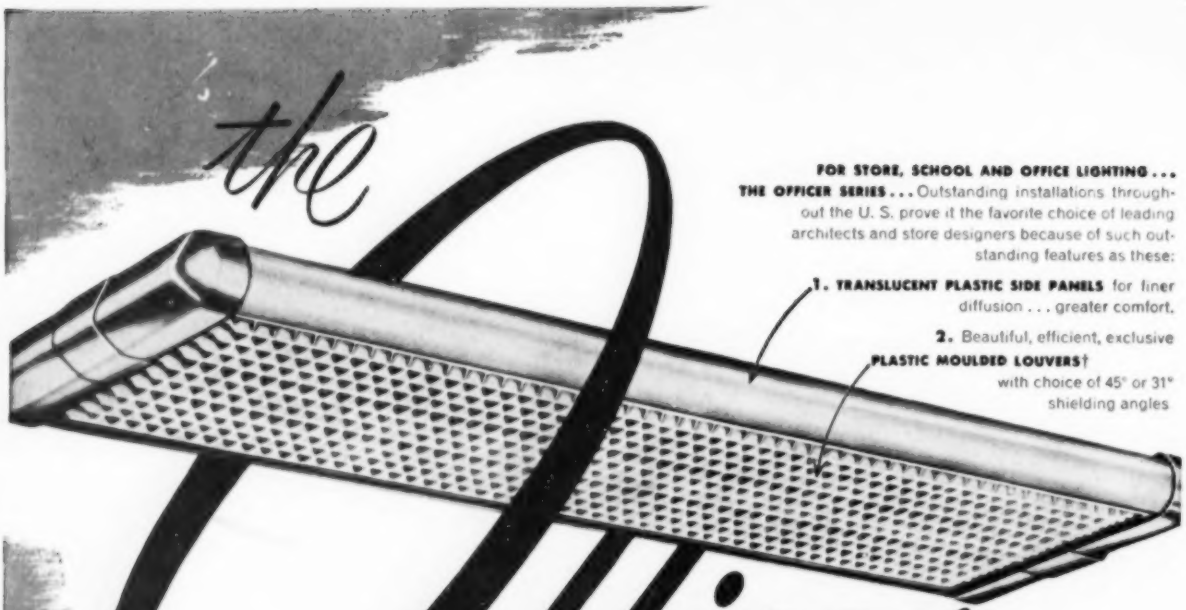
ILLUMINATING ENGINEERING

NOVEMBER 1954

Xenon Short-Arc Lamps and Their Application
Problems in Design of Fluorescent Lamps
Determinants of Fluorescent Lamp Life
Winners — National Lighting Contest
Quartz in the Lighting Industry
Classification of Luminaires
Dimmers for Light Control

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY



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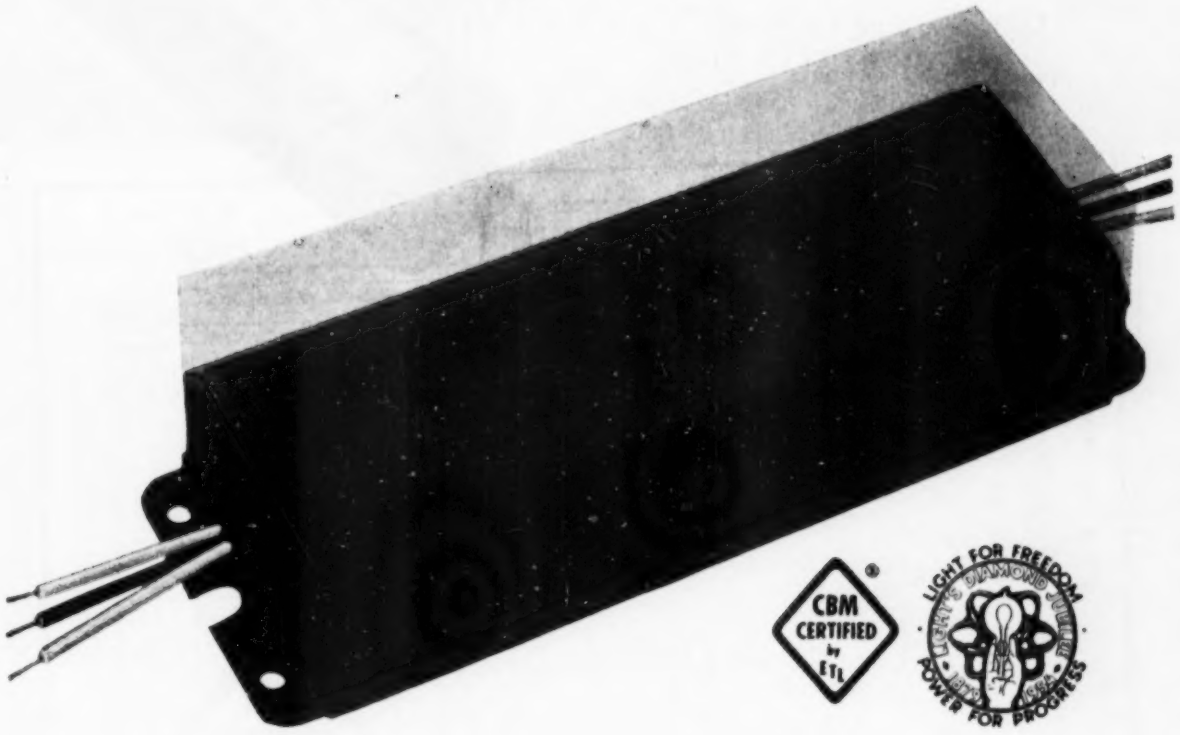
New small-size Westinghouse ballasts



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A new Slimline Ballast

Check these Electrical Testing Laboratories' Data
on the Starring

196-HPF

against Proposed ASA Specification C82.1

ELECTRICAL TESTING LABORATORIES, INC.

TESTS OF FLUORESCENT LAMP BALLASTS

PAGE 1 OF 1

MFR. Starring & Co., Inc. PLANT Bridgeport, Conn. DATE SELECTED 2/6/54 BY
CAT. NO. 196 HPF CSP 1-96 T12 AMPS DATE RECEIVED 2/6/54 ETL ORDER NO. 92463-14
RATING UNITS 73.5 VOLTS 118 W. 426 CYCLES 60 DATE TESTED 2/10/54-4/2/54 TESTED BY A.J.C. DATA APPROVED HHC

ETL SPEC. NO.	CIRCUIT	SUPPLY VOLTAGE VOLTS	WATTS (INPUT)	AMPS (INPUT)	INPUT TO REFERENCE LAMPS: VOLTAGE VOLTS	CURRENT AMPS	POWER WATTS	POWER FACTOR %	RATIO HIGH TO LOW CURRENT	CIRCUIT LOSS WATTS	CAL BALLAST LOSS AT RATED VOLTS WATTS	OVERALL POWER FACTOR %	VALVE SHAPE	VOLTAGE ACROSS STARTER TERMINALS AT RATED VOLTS	DI-ELECTRIC STRENGTH TEST	100 CPS HIPOT	TIME SEC.	WEIGHT GRAMS	HEATING TEST: COIL RESISTANCE OHMS Before / After	CASE TEMP. °C
92463	Comm.				196.0	0.426	78.0													
"		66			80.0	0.334	66.8													
"		118			196.0	0.334	65.5													
"		132			130.0	0.298	50.8													
T-78	Rapid	118	57.5	0.49		0.428	76.0	0.320	1.66											
"	Rapid	"				0.870	77.3													
T-79	Rapid	"	87.0	0.78		0.908	78.4	0.60	1.67		83.3	98.7								
"	Rapid	"				0.870	76.3													
T-80	Rapid	118	89.0				83.0				84.9	91.8								
"	Rapid	"					83.0													
"	Rapid	"				0.428	73.5	0.592	1.61											
"	Rapid	"				0.868	78.5													
"	Rapid	118	68.5				82.4				84.6	93.0								
T-81	Rapid	118		0.85			82.4													
"	Rapid	"					82.4													
"	Rapid	118				0.865	76.6	0.570	1.66											
"	Rapid	"				0.870	76.8													
"	Rapid	118	67.8				82.0				82.7	83.6								
T-82	Rapid	"					82.0													
"	Rapid	118	67.5				82.5													
"	Rapid	"				0.868	76.4	0.566	1.65											
"	Rapid	118				0.870	76.9													
"	Rapid	118		0.82			82.4				27.9	33.4								
Ballast		66.5			196.0	0.870	78.4													

Lamps on Rapid-Start Ballasts in Circuit

CBM CERTIFIED by ETL

Check them against performance data on any competitive ballast, and you will know why we say "Starring Ballasts are Engineered into Leadership."

STARRING
& Company, Inc.
1600 Seaview Avenue
EDison 4-0108 Bridgeport 7, Connecticut

196-HPF
11 9/16" x 3 3/16" x 2 9/16"
Mounting Length 11 1/8"
Weight 9.9 pounds

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

November
1954

Vol. XLIX
No. 11

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STATEMENTS and opinions in articles and papers in ILLUMINATING ENGINEERING are the expressions of contributors and do not necessarily represent the policies or opinions of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council of the Illuminating Engineering Society.

Founded 1906

ILLUMINATING ENGINEERING SOCIETY

A. D. Hinckley
Executive Secretary

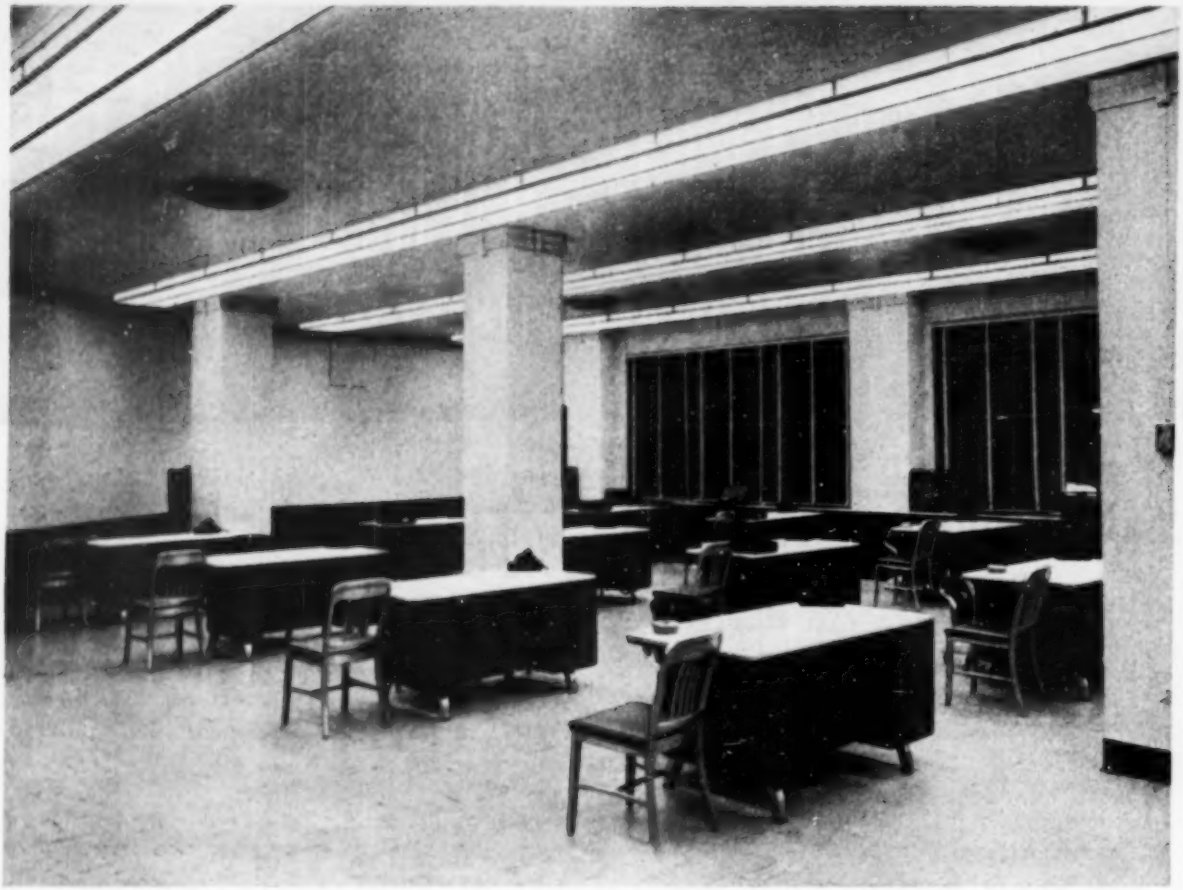
C. L. Crouch
Technical Director

PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.

EDITORIAL and advertising offices 1860 Broadway, New York 23, N. Y.

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1954 by the Illuminating Engineering Society.

Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $12 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.00. ¶ Address changes must be received at I.E.S. headquarters by the first of the month to be effective with the issue of the next succeeding month.



Paired Fixtures show LITECONTROL Flexibility

INSTALLATION: Niagara Mohawk Power Corporation, Electric Building, Buffalo, New York
ILLUMINATING ENGINEER: Mr. J. F. Parsons, Niagara Mohawk Power Corporation
AREA: Customer's Service Office — 77' x 40'
CEILING HEIGHT: 11'-6"
FIXTURES: Litecontrol No. 3724, with Holophane No. 9016 lenses, 2-F96T12 standard warm white lamps; fixtures arranged in double rows
SPACING: 10' on centers
REFLECTION FACTORS: Ceiling 80%, walls 30%, floor 30%, desk tops 30%
INTENSITY: 90 Footcandles in service
BRIGHTNESS READINGS ON LENSES:
70 degrees — 180 footlamberts
60 degrees — 270 footlamberts
45 degrees — 950 footlamberts
0 degrees — 1800 footlamberts

Striking good looks mark this unusual solution to office lighting problems. Standard LITECONTROL 3724 shallow "surface troffers" were mounted side by side, forming a double width unit which gives high intensity light with very little increase in brightness.

Adjacent glass side panels were omitted and the fixtures joined by means of small clips. Installation was simple and rapid. Although joined into a single unit, fixture doors still swing fully open on hinges, at a finger's touch on the *snap-lock* triggers, for easy cleaning and maintenance.

Holophane low brightness lenses, diffusing glass side panels and light-toned interior decoration complete a picture of outstanding lighting for day-long office comfort . . . *custom lighting* with *standard fixtures*. Let us show you how LITECONTROL efficiency and versatility can work for you. Call or write your local representative today.

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DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

Floyd Sell

Duncan Preston

Design for Inspection Lighting

THE PATH of a projectile after it leaves the gun is to a great extent dependent upon the precise burning of the powder charge in the gun. Burning of the powder in the cartridge is regulated by the slender primer tube which contains the ignition charge, with small openings in the side of the tube controlling the burning rate of the surrounding powder.

The method evolved, in this prize-winning solution to a lighting problem, was for inspecting the inner surface of the primer tube. Basic fundamentals of light and sight were used in combination with some comparatively new materials and with engineering ingenuity.

Steel primer tubes — $\frac{3}{8}$-inch diameter bore — are plated with zinc to prevent corrosion. Since

FIRST PRIZE

The design for this unique lighting inspection device won the grand prize in the national I.E.S. contest for "My Most Interesting Lighting Job" at the I.E.S. National Technical Conference in Atlantic City. Previously this entry had won first prize in the Michigan Section and the Great Lakes Region of I.E.S. Mr. Sell and Mr. Preston are Illuminating Engineers with the Detroit Edison Company, Detroit

there is almost no color difference between zinc and steel, visual inspection of the coating is almost impossible, and a dichromate wash is added as an indicator. This dichromate has the property of adhering to the zinc plating, giving it the appearance of brass, while having no color effect on unplated steel.

Inspection of the thoroughness of this coating of zinc had formerly been by cutting open 100 tubes out of each 1000 produced. The condition of these samples determined acceptance or rejection of the entire lot. This was a costly process, and also resulted in production bottlenecks.

The manufacturers, the Detroit Plating Company, called for assistance, and the two I.E.S. members began devising a better method of inspection. Since the highly specular surface inside the tube simply reflected the brightness of a light source, just looking into the tube gave no indication of the surface color.

Preliminary Designs

Working first with the idea that light should enter the tube from the viewing end, they set up an optical assembly, using a 15-watt automotive lamp for a concentrated light source. The beam from the lamp was passed into the tube through a condensing lens, and a reflected view of the inner surface was obtained with a mirror. With this assembly, glare was greatly reduced but visibility was poor because of insufficient light on the side walls inside the tube.

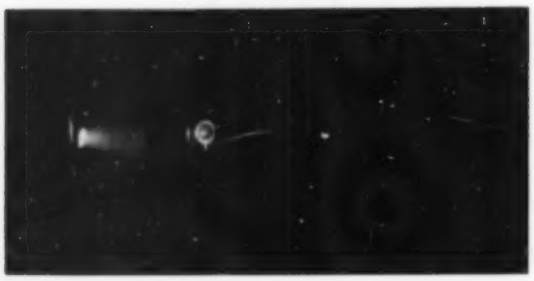
In an attempt to confine the light to the area being inspected, a wooden dowel with the end painted white was inserted in the tube from the opposite end. This gave somewhat improved visibility. Next a ball bearing was tried on the tip of the dowel, but distortion and reflected glare from the center of the bearing made this method unsatisfactory.

For a final try in this series of experiments, the end of the dowel was cut at a 45-degree angle and a mirror cemented in place. In this way light was directed to a small area of the inner surface and the mirror could also be used to view that surface. This method was satisfactory for inspecting the inner surface to a distance half-way in the tube, but it was cumbersome and too exacting to be practical for large volume inspection.

Final Design

The final phase of development began an entirely new approach. In this, light is conducted through a solid plastic rod, which transmits it efficiently providing the outer surface is highly polished. Light is conducted into one end of the tube through the plastic rod, leaving the other end unobstructed for viewing by the inspector.

Many shapes were tried on the viewing end of the rod, to confine the emerging light to the area being inspected. Sawing, filing, polishing, gluing on mirrors — the chief source of trouble was the excessive brightness of the rod where the light came out.

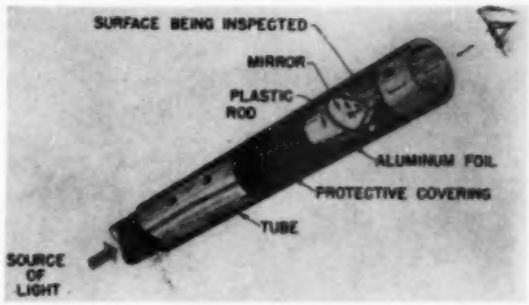


Preliminary Designs

Using the optical system shown at left, preliminary designs to light the interior of the primer tube were:
Below left: End of rod painted white.

Below center: Ball bearing mounted on end of rod.

Below right: Mirror cemented at 45-degree angle on end of rod. This system was effective in lighting the interior surface of the tube, but was too cumbersome to be practical.



Final Design

Light emerging from the small window in the plastic rod is directed at the primer tube wall at an angle normal to the surface, is reflected to the mirror, and from there to the eye of the inspector. The view seen by the inspector is shown in the photo on page 503. The interior of the tube inspected there has obvious defects in coating.

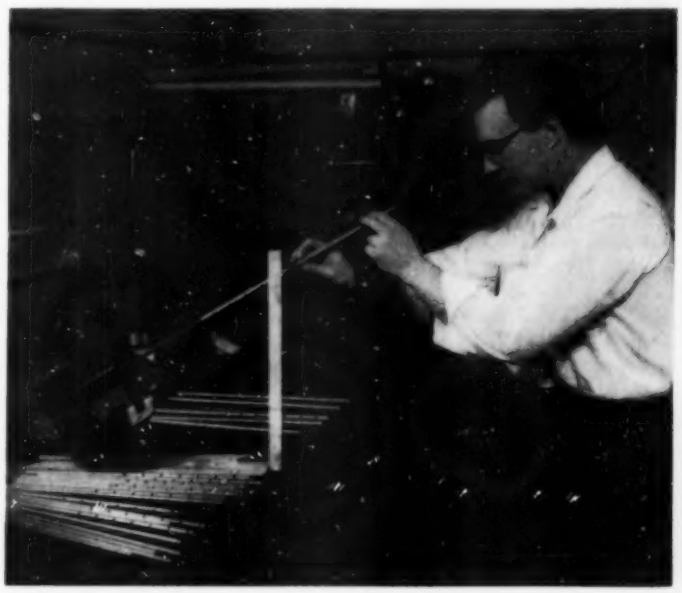
The final design, as shown in the diagram above, allowed the light to come out at a point beyond the viewing mirror. By the correct shaping of this surface, light was made to strike the primer tube wall in such a manner that direct and reflected glare were minimized. Light emerging from the small window at the end of the rod strikes the inner surface of the tube normal to that surface, with maximum effectiveness.

To prevent scratching, the plastic rod was encased in aluminum foil and then covered with tape for further protection. All surfaces are now covered except the mirror, the light emitting window and the end of the primer tube where the light enters.

How well this final design works is shown in the photograph on page 503. The smallest details are revealed to the inspector, free of confusing highlights, shadows or glare.

Shown in the photo below is the proof of the pudding — the device in actual use on the job. The inspector slides the tube down over the plastic rod, which is securely attached to the lamp and lens housing shown at the lower left. He can inspect every square inch of the surface by rotating the tube.

Although the device is no power consumer, using only 15 watts, it successfully solved an inspection problem which had heretofore been costly both in materials and in production time.



The device in actual use on the job. The inspector slides the tube down the plastic rod, inspecting every square inch of the interior surface. Lens and lamp housing are at lower left.

Floodlighting for a Dual Celebration

By Day

SECOND PRIZE

J. J. Tynan

The floodlighting of his company's general office building won for this lighting specialist of The Atlantic City Electric Company the second place award in the National contest for "My Most Interesting Lighting Job." To compete in this contest the installation had previously won first prize in the Philadelphia Section and the East Central Region.

THIS YEAR, 1954, has been a dual celebration in Atlantic City, New Jersey: Light's Diamond Jubilee and the centennial anniversary of the founding of the city.

In celebration of these two events, the Atlantic City Electric Company decided to illuminate the exterior of its own general office building in a manner that would set a good example for others in the city to follow. Since the five-storey, gray brick structure is located in a densely built-up commercial part of the city, at the intersection of two relatively narrow streets, the task of planning conservative as well as attractive floodlighting imposed a stimulating challenge to those charged with the responsibility.

The Problem

In 1929 during Light's Golden Jubilee, the building had been floodlighted from two directions: on Pacific Avenue from the roof of the Telephone Company Building, and on Kentucky Avenue from the roof of an apartment building. The entire installation had been removed when wartime regulations prohibited the use of floodlighting.

To re-light the building as before was impractical, expensive and complicated, and conditions made it mandatory to develop a plan of exterior lighting that would be self-contained, as it were—

to have a form of lighting that could be attached to the building itself. The management had delivered a ukase which directed that any lighting being considered would have to be conservative, dignified, flexible for color use, and of a permanent nature based on a 15-year period of obsolescence. Another prerequisite was that the lighting scheme should serve as a model as a sales aid in the promotion of floodlighting for other commercial and civic buildings.

The problem was turned over to the utility's own lighting specialists of the Atlantic City Division to devise a solution to all these conditions and requirements. After a discussion on a few basic ideas, two sample hardboard fixtures were built and attached to the exterior brick wall of the building for experimental purposes. This trial installation enabled a study of how the lighting urns would appear during the daytime, and a clearer visualization of night-time aesthetic effects, vertical beam control, amount of spill light to adjacent buildings and the optical sensation of highlights and shadows resulting from irregularities in the rough textured brick surface.

By Night

The Solution

Of the two possible methods of floodlighting — either general lighting or finger accent lighting — the latter method was selected. The architecture of the building creates ten main columns and sixteen intermediate columns formed by the windows. On the main columns, copper urn-type units, pretreated with acid, were built to house three 300-watt PAR-56 narrow-beam spotlamps as the upward component and one 150-watt PAR-38 spotlamp as the downward component, lighting the limestone columns and pavement. These are mounted at a level between the first and second floors. The intermediate units, mounted at the same level, are smaller in size and each contains one 300-watt PAR-56 narrow-beam spotlamp pointing upward. This section is fed from one 100-ampere two-pole safety switch as a single circuit, providing flexibility.

The 34 top units, on a second 100-ampere circuit, are mounted at the bottom of the fifth floor window level for easy maintenance and are even smaller than the intermediate column units below. Each contains one 150-watt PAR-38 spotlamp and they are so spaced as to provide an even distribution of light of high illumination level at the top of the building. Existing lanterns on each side of the front entrance of the building were modified to have one 300-watt PAR-56 spot at the top, one 150-watt PAR-38 spot at the bottom and one 100-watt standard lamp as a pilot light. All the PAR-56 lamps face upward and are equipped with protective clear lenses for protection against rain or snow.

The Results

In addition to supplying effective floodlighting for the office building, the installation has been deemed highly successful on some other counts:

(1) Of paramount importance is the fact that adjacent apartment house dwellers have voiced no complaints.

(2) Local merchants, hotel operators and civic leaders manifested more than an academic interest in the installation, since one of the main stumbling blocks to beachfront hotel lighting is the matter of light being beamed directly into guest rooms.

(3) Lamp inventories are kept at a minimum since only two sizes and types are used.

(4) Simplicity is such that color lenses can be readily attached for special events and can be operated in whole or part. The installation is readily serviced and maintained.

Basically the same type luminaire is used in the lobby (left) and the waiting concourse (opposite page). Units in the lobby are framed to be 6 feet square; those in the concourse are 8 feet square.

Lighting . . . correlated with architecture, designed for comfortable seeing, with built-in maintenance features . . . In a Railway Terminal

THIRD PRIZE

Louis N. Goodman

This "most interesting lighting job" in a railway passenger terminal won the third prize in the I.E.S. National contest, having scored first in the competitions held by the New Orleans Section and the Southern Region. Mr. Goodman is a Consulting Engineer in New Orleans.

FREQUENTLY a lighting engineer finds that designing for a given illumination level is only one small part of his job. The lighting system designed for the Lobby and Waiting Concourse of the new Union Passenger Terminal in New Orleans amply proves the truth of this statement.

The lobby and concourse form a T-shaped open area. The concourse is 242 ft by 69 ft with ceiling height of 18½ ft. The lobby measures 61 by 44 ft with ceiling 14½ ft high. In both areas, ceilings are of light ivory acoustical tile and plaster. Side walls are of red Levanto marble except for long expanses of colorful hand-painted murals, and sections of train-posting boards, telephone booths, lunch counters, lockers and entrance ways — all functionally necessary in a railway terminal. End walls in the concourse are taken up by windows and doors, with the windows masked by aluminum grills. Floors are buff and light gray terrazzo.

The simple, modern architectural treatment called for a lighting design quite unpretentious in appearance, with rather large luminaires for a

pleasing physical proportion with the large-area interiors being lighted.

It was also apparent that with the expanses of flat and relatively low ceiling, suspended, or even some surface-mounted, luminaires would materially interfere with the concept of maximum spaciousness desired by the architects. The consideration of illumination levels in keeping with the modern touch, could not, of course, be neglected. Further, the adequate lighting of the colorful wall murals must be achieved without additional local lighting prohibited by the artist creator of the murals.

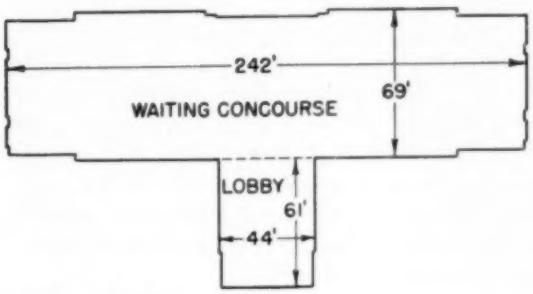
Other problems which demanded consideration were:

(1) Proper shielding to prevent direct glare from normal viewing angles, and reflected glare from the highly specular polished marble walls.

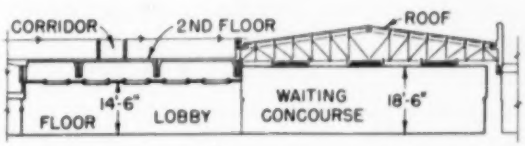
(2) Control of illumination level for reduction in power consumption during early morning hours; and an emergency lighting system incorporated, if possible, in the main lighting system.

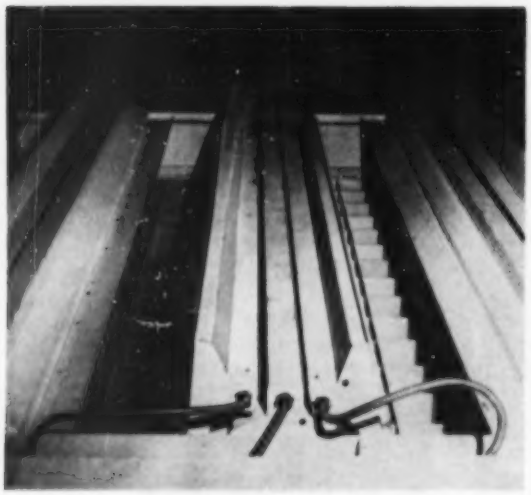
(3) The ever-present problem of maintenance. The ability to re-lamp, clean reflectors and louvers, and replace defective ballasts and other parts from attic spaces would avoid the necessity for portable service platforms and their attendant hazards to pedestrian traffic. The handling of bulky louvers or several louver sections during re-lamping would be avoided. The use of fixed, single-section, structurally strong louvers would be made possible.

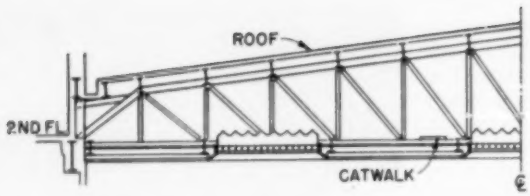
To preserve the concept of spaciousness and to maintain proper physical proportions, large, flush-ceiling-mounted, egg-crate louvered-bottom fluorescent luminaires were designed and manufactured.



Plan view (left) and elevation (below) give dimensions of terminal.







Cleaning and re-lamping is done from catwalk. Each reflector has piano-type hinge on one side, and maintenance is a one-man job. Note "bull's eyes" on each reflector to indicate lighted or unlighted lamps.

In the concourse 48 of these units were used, and in the lobby 15. Concourse units are 8 ft square and lobby units 6 ft by 8 ft, framed at the ceiling to appear 6 ft square. This allowed the use of the same 96-inch lamps and takes advantage of the higher light output through the 6-ft-square openings.

Each luminaire consists of an angle-iron-reinforced sheet-metal frame in the top of which are mounted industrial-type, specially designed and fabricated reflectors and lamp holders for T12, 96-inch, standard cool white lamps, 8 each for concourse units and 6 each for lobby units. Reflectors have continuous piano-type hinges down one side. Below the reflectors, resting on continuous steel shelf angle is the egg-crate louver of ¼-inch thick anodized aluminum plate. Louver openings are 6 by 6-inch by 4 inches high for the concourse units and 4 by 4-inch by 4 inches high for lobby units. Cut-off is 35 and 45 degrees respectively.

Lamps are spaced approximately 12 inches apart, 11 inches above the top of the louver. Ballasts are externally mounted in 4 by 4-inch by 96-inch hinged-cover ballast boxes mounted beside each fixture frame.

Illumination levels were a comfortable 35 to 40 footcandles after 1800 hours operation, with 8 to 12 footcandles on the vertical surfaces of the wall murals.

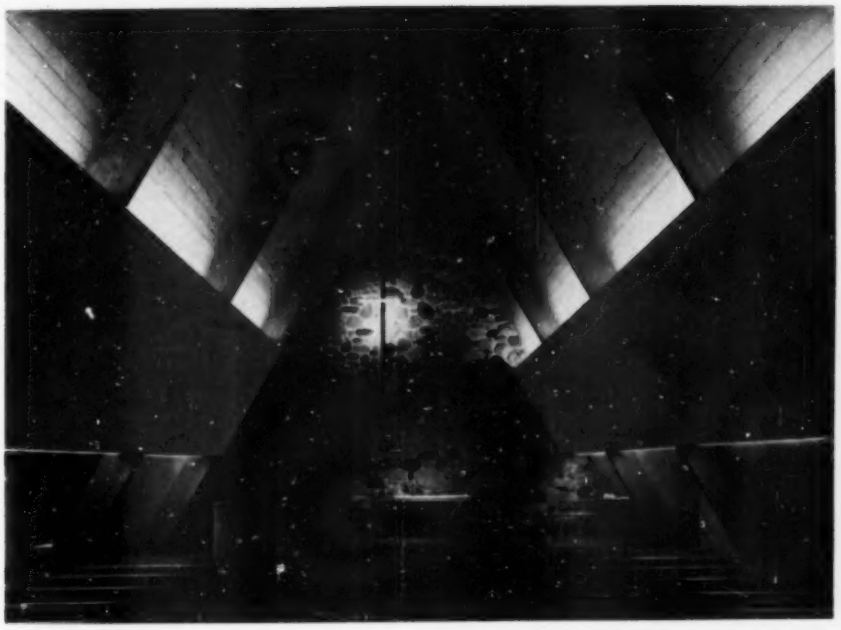
Emergency lighting is obtained by connecting two symmetrically located lamps in alternate luminaires on emergency circuits. In the lobby units the lamps on emergency circuits provide the "low-level" illumination, which in the concourse is provided by two symmetrically-located lamps in each luminaire. "High-level," "low-level" and "off" controls are conveniently located toggle switches which operate remote magnetic contactors in feeder circuits supplying branch circuit panelboards.

Maintenance

Features built into the overall system for maintenance have greatly simplified this operation. Cat-walks are provided in the spacious attic for easy access to each luminaire. Since each reflector has a continuous piano-type hinge on one side, lamp changing and reflector cleaning can be done by one man, simply by raising the desired reflector. The louver, which is designed to bear the weight of a man, may be cleaned with reflectors in the open position. Dust on the louvers, however, has little effect on light output, due to the large size of the openings.

Red glass jewel "bull's eyes" are provided in each end of each reflector housing, giving visual indication of lighted or unlighted lamps.

Separate gang-mounting of ballasts provides easy access for servicing. The ballast boxes are mounted on the catwalk steel supporting member, which serves to dissipate ballast heat by conduction into the heavy steel mass. Ballasts for lamps on emergency circuits are separated by steel barriers from those on normal circuits.



CHURCH LIGHTING
in a modern mode

INGENUITY and originality can be exercised most readily in lighting design when the architect produces an original and ingenious structural design. In the case of St. Anselm's Church in Vancouver, British Columbia, the architectural firm of Semons & Simpson, winners of Canada's top architecture award, designed a modern church with all the desired features — and on a strict budget. The church seats 144 in permanent pews and an additional 50 in temporary seats.

The problem in the lighting design was that of preserving and complementing this architectural treatment, and at the same time providing comfortable and adequate illumination. With only $1800 allotted for lighting fixtures for both the church and the parish hall, the decision was made to spend it all on the church. If the lighting were *really* poor in the parish hall, something would be done later to improve it, and adequate wiring was provided with this expectation in mind.

In the nave of the church, with its cross-section forming an equilateral triangle, conventional luminaires would obviously be out of place, and in

FOURTH PRIZE

Eric Ackland

The lighting installation in St. Anselm's Church won the fourth prize at the I.E.S. National contest for "My Most Interesting Lighting Job," having previously won first place in the British Columbia Section and the Pacific Northwest Region. Mr. Ackland is a consulting engineer with offices in Vancouver, B. C. and Edmonton, Alta.

Angle of beams of the floodlamps, 42 degrees with the center line of the church, keeps to a minimum the brightness in the line of vision of the minister.

keeping with the very modern design of the architecture, concealed lighting seemed the proper solution.

The units which supply the main downlighting are truncated cones, each designed to hold an R40 floodlamp with a 45-degree concentric louver. Wiring was installed to take 300-watt lamps and 200-watt floods were originally installed — later changed to 150 watts. Each of these cones is so mounted, at a height of 16 feet, on the chancel side of the trusses that the beams of light cross from each side at an angle of 42 degrees with the center line of the church, and forward making an angle of 40 degrees from the vertical axis. Each unit is completely shielded from the view of the congregation, and the angle of the beams keeps to a minimum the brightness in the line of vision of the minister.

To reduce brightness contrasts and provide a lighted background, a row of 96-inch single-lamp slimline units with warm white lamps, on 300 ma, are mounted at the top and bottom of the side wall panels. Those at the bottom are shielded with 35-degree louvers, while those at the top are open.

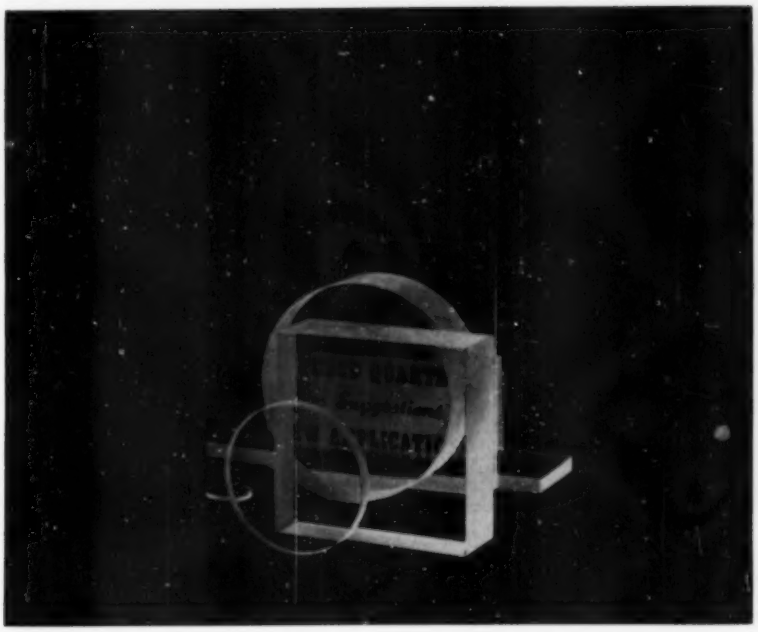
Illumination level in service ranges from 11 to 16 footcandles six months after installation.

The altar is highlighted with two 300-watt R40 floodlamps, and the Cross with one 300-watt R40 spot. Attempts to spotlight the pulpit at the time of the installation were defeated, but this feature was later added by those who at first had opposed the idea.

A side area, provided for latecomers to enter unobtrusively and which serves as space for temporary seating, is lighted by soffit boxes with diffusing glass covers, using 100-watt incandescent lamps.

Outside, planting boxes are lighted with 75-watt R30 spotlights. A covered walkway from the entrance of the church around the side to the parish hall is lighted with small truncated copper cones, each equipped with a 60-watt incandescent lamp.

A side area provided for temporary seating is lighted with incandescent soffit boxes. For those who note the architectural paradox in this photo, the organ is temporary and money is being raised for one especially designed for the church.



Characteristics of Fused Quartz

By C. E. WEITZ

LAST YEAR there were nearly half a million mercury lamps made and sold in which the heart of the lamp was a fused quartz arc-tube. It is because of the extraordinary characteristics of fused quartz that have made possible many of the designs of present types of mercury lamps.

All I.E.S. members are familiar with the present-day mercury lamps 100 to 1000 watts used for general lighting for factories and streets, and for sunlamp and specialized black light applications. Such lamps use a quartz arc tube enclosed by an outer glass bulb to maintain high arc temperatures. Less well known are those quartz lamps used for photochemical applications. Such lamps are available in single tubular bulbs one-half to three-quarters inch in diameter in lengths from about six inches to over 50 inches.

Quartz might be called thoroughbred glass. It is pure silicon dioxide (SiO_2), called silica. The two elements silicon and oxygen are the most abundant of all the 98 elements. Oxygen ranks first, silicon next, in all the earth's materials. Silica is the major part of plain, ordinary sand and makes up about a quarter of the earth's land surface. Air is 20 per cent oxygen and a good share of the earth's minerals are oxides in one form or another.

In the article on the characteristics of glass in the June issue of ILLUMINATING ENGINEERING, it was brought out that glass is basically silica compounded with various other metallic oxides to produce glassware of various characteristics. Eliminate all of these extra ingredients and you have quartz. The production of glass in this country runs in millions of tons each year, fused quartz perhaps 100 tons. You can buy a pint of mayonnaise in a glass jar for 30 cents, but if the jar were made of quartz, it might cost several dollars without the mayonnaise. Therein lies a story of quartz making and quartz characteristics.

Crystal Quartz from Brazil

Quartz in its natural state is in the form of transparent crystals from pinhead to boulder sizes. Biggest single crystal ever found was a yard in length and diameter and weighed half a ton. Most of our quartz comes from Brazil in walnut sized

AUTHOR: General Electric Co., Lamp Division, Nela Park, Cleveland, Ohio.

CRYSTALS. Brazilian quartz rock crystals, egg-size, look like this when they arrive in this country.

crystals and costs from 15 to 50 cents a pound as a raw material.

Natural quartz crystals have found many uses in radio, for lenses, and for prisms for photometers, and other highly scientific optical apparatus. The reason is that quartz either crystal or fused has the highest transmission of ultraviolet, visible and infrared radiation of any known material (except impractical fluorite). This transmission figure for a thickness of one millimeter hovers around 90 per cent throughout the lamp spectrum range from 2000Å to 38 000Å. It tapers down from there on out both in the far ultraviolet and in the infrared. Little data are available on transmission at lesser wavelengths than 2000Å in the far ultraviolet. (See curves.)

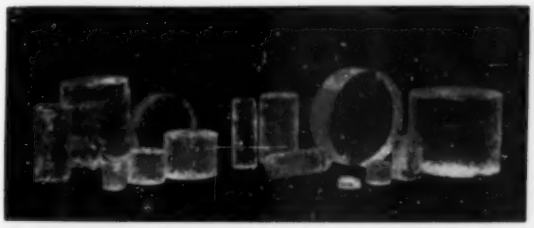
Crystal quartz can't be used for lamps and many other applications. While the melting point of quartz is 1756°C (3193°F) (copper melts at 1083° — iron at 1535°), quartz crystals change character and may shatter at temperatures around 600°C. It seems that even in compacted crystal particles there is bound to be as much as 30 per cent of air or void space.

CRUCIBLE FUSING. The quartz crystals are loaded into cylindrical graphite containers which go into an electric furnace. Melted under vacuum, the crystals fuse into a solid ingot. Various sizes of molds are used.

Processing Transparent Fused Quartz

Making fused quartz is a matter of getting rid of voids between individual particles. This involves melting the quartz crystals under vacuum and later refusing under pressure so that the bubbles are minimized. The quartz is thereby compacted into a non-crystalline solid. The coefficient of expansion of fused quartz is lower than that of any commonly known material over a wide temperature range. It is $^1/_{24}$ of copper, $^1/_{17}$ of platinum, $^1/_9$ of tungsten, $^1/_7$ of hard borosilicate glass, $^1/_{10}$ of graphite. This extraordinary property is of tremendous significance in many scientific uses. But in processing and in lamp making it introduces problems.

For example, every ingot cast has to have its own mold which can be used only once. Because of its high melting temperature, graphite molds (melting point 3500°C) are used. As the quartz is melted, the graphite mold expands and the melted quartz follows the expanded mold size. When the combination cools the quartz contracts very little, the graphite much more. Something has to give.



INGOTS. These come out of the fusing furnace looking crazed and pock-marked from the graphite mold which disintegrates upon cooling. Ingots are cast up to 19 inches in diameter, up to 8 inches in length. They look like this.

The mold shatters because the fused quartz will withstand 190,000 pounds per square inch under compression.

As the mold breaks away, some of the quartz adheres to the graphite, leaving the ingot surface pitted and non-uniform. Grinding the rough surfaces smooth represents unavoidable waste of material.

As far as quartz arc tubes for lamps are concerned, the low expansion of quartz compared to metals therefore poses quite a problem of sealing lead wires into the tubes for electrode connections. This has required much research. Presently, molybdenum foil is being used in higher wattage types.

Ingots are cast in cylindrical shape in sizes from 1 to 19 inches in diameter — four to eight inches in length. For quartz tubing, solid ingots are pierced at high temperatures by driving a graphite rod through the center. Small diameter rods and tubing are made by heating up the solid or pierced ingot and drawing in much the same way as glass is drawn. But with quartz it is much trickier. Quartz doesn't seem to want to flow evenly and smoothly. It is hard to maintain precise inside and outside diameters. This causes considerable loss by rejects where tolerances are small.

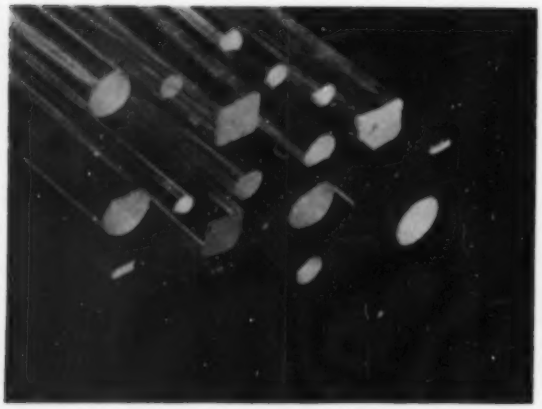
Grinding, Cutting, Finishing

The rough surfaces of a fused quartz ingot can be ground smooth on a grinding wheel faster than glass because of its resistance to thermal shock. You can take a quartz rod, heat it red hot with a blow torch and pour ice water on the quartz next to the flame and nothing happens.

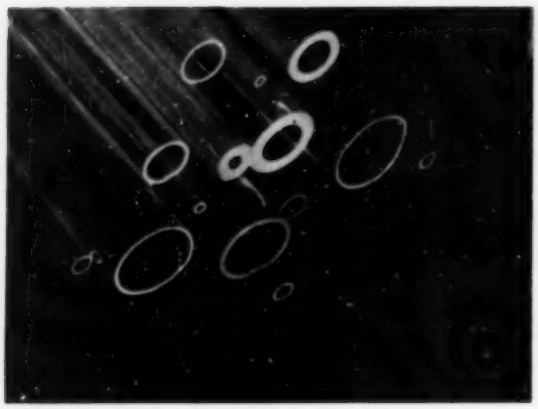
Advantage is taken of this quality in making motion picture projection condenser lenses out of fused quartz. Here a high intensity carbon arc may be used only a few inches from the lens. No matter how high the temperature gradient from the center of the lens to the edge, this makes little

GRINDING and POLISHING. The rough surface of ingots may be ground off smoothly and polished to lens precision. Because of its high resistance to thermal shock and lack of distortion due to the heat of friction, quartz can be ground faster than can glass.

DRAWING into rods and tubing. Ingots, either solid or pierced, are placed in a furnace, heated and drawn into rods or tubing in much the same way as glass; more difficulties are presented, however, in obtaining uniformity. A fused quartz ingot, solid or pierced, may be drawn into smaller sizes in this manner.



RODS. Transparent rods are drawn in sizes from 1 to 37 millimeters in diameter (you figure it out in inches at the rate of 25.4 mm per inch); in lengths up to 5 feet feet; cost is from 20 cents per foot up to 25 dollars per foot. Translucent rods are drawn in sizes from ⅛-inch to 1½-inch diameters, in lengths up to 10 feet; cost is from 20 cents to 10 dollars per foot.



TUBING. Transparent tubing runs from 1 to 32 millimeter bore, with a price range from 35 cents to 10 dollars per foot. Translucent tubing ranges from 1/25-inch bore up to a 6-inch bore. Price is from 30 cents up to 22 dollars per foot. Approximate price range per pound figures out about 12 dollars per pound for the minimum bore to about 5 dollars per pound for the larger diameters.

difference to quartz. Glass won't stand up under severe temperatures or gradients.

You cut quartz rods or tubing with a thin, high-speed abrasive wheel instead of scratching the surface and breaking like you do with glass. Quartz is hard to scratch in the first place, can't be done with a sharp knife.

Because of its hardness, imperviousness to uneven temperatures, and its minute change in size with temperature, quartz shapes such as flat disks, an inch or so thick, can be ground and polished so the surfaces do not depart more than one-fifth of the yellow-light wavelength from true planes. In other words, approximately four-millionths of an inch. These are the flattest surfaces in the world. They are called "optical flats." One use of sodium lamps which produce only yellow light, principally in one wavelength (5893Å) is the "lab-arc" for inspection of such surfaces. The precision and constancy of such surfaces regardless of temperature make fused quartz shapes the most accurate standard for precision gauge blocks.

Translucent Fused Quartz

This is made from sand. Ordinary sand that you might scoop up from beaches or sand dunes most anywhere has a lot of impurities in it. The sand used for translucent fused quartz is mined — most of it coming from pits in Illinois. It is 99.7 per cent pure silica, so it doesn't present so many problems of purification as would ordinary sand such as you and I encounter on the beach.

Translucent fused quartz has approximately the same temperature characteristics as fused crystal quartz. The difference between clear fused quartz made from clear quartz crystals, and translucent quartz made from the purest silica sand is largely one of manufacturing and application economics; in other words, which is cheapest for the job requirements. The differentiation between clear transparent fused quartz and translucent quartz is that, in the latter, they don't try to squeeze all the air voids or bubbles out. So when the translucent quartz is drawn into rod or tubing the imprisoned bubbles are drawn out into minute elongated streaks giving a satiny appearance. This is due to refraction of light rays between the solid quartz and the variable voids. Diffusion, in a sense. For many uses where precise optical properties are not concerned, translucent quartz serves equally well and for some applications as good or better than clear quartz. Cheaper to make, too. Naturally the crushing strength, tensile strength, etc., are somewhat lower than for clear, solid quartz.

Chemical and Electrical Properties

Fused quartz has unique electrical and chemical properties. Its high resistivity, low dielectric losses (particularly at high temperatures), and its ability to withstand wide and sudden temperature changes make it superior to plastics, glass and porcelain as an electrical insulator.

Fused quartz is chemically inert to almost all acids, hydrofluoric and phosphoric excepted. Even

EXTRAORDINARY thermal characteristics of quartz. These can be demonstrated by heating a rod with a blow-torch while a stream of water is poured on the red-hot quartz.

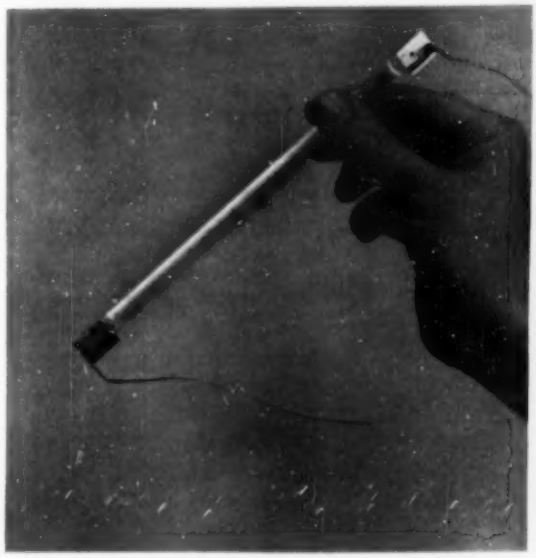
then these acids affect quartz to a lesser extent than with glass or other ceramic materials. This accounts for one special market for quartz — namely, flasks, beakers, tubing, for chemical laboratories.

A further attribute, perhaps more rightly called a mechanical property, is the elasticity rating. Elasticity, in engineering concept, is not its ability to stretch like rubber, but rather its resistance to change shape under stress and its ability to snap back to its original shape without distortion. On this basis quartz has almost perfect elasticity. A thread of quartz is most excellent for suspension of galvanometer mirrors. The quartz fiber will untwist completely after being twisted through a large angle and come to rest reliably at zero reading after each deflection.

Fused Quartz Arc Tubes for Mercury Lamps

Basic to the design of modern high efficiency mercury vapor lamps (introduced in 1934) was operation at much higher vapor pressures than early Cooper-Hewitt type lamps. The latter vapor pressure was about one-ten-thousandth of an atmosphere. The best lamp efficiency achieved in a 50-inch glass tube was about 25 lumens per watt. With vapor pressures multiplied ten thousand or more times, higher luminous efficiency was obtained — 30 to 65 lumens per watt in present-day mercury lamps. The design of the 400-watt A-1 lamp has a hard glass arc tube length of six inches and a loading of 67 watts per inch, and a vapor pressure of 1.2 atmosphere. Its light output rating is 15,000 lumens. The 400-watt E-1 lamp developed later has a quartz arc tube. Its length is 2¾ inches and has a loading of 145 watts per inch. It operates at higher arc tube temperature and pressure and its light output rating is 20,000 lumens. To maintain these pressures high tube temperature is required. Arc tube temperature is in the neighborhood of 800°C with vapor pressure of about four atmospheres. Fused quartz withstands such operating temperatures and pressures without difficulty. Then, too, there are no impurities in quartz to seep into the arc tube and contaminate the mercury vapor.

Quartz tubing is used in various types of photochemical lamps available in lengths from seven to over 50 inches. In such lamps internal vapor pressures are not so high since ultraviolet production instead of visible light is the purpose of the design. Quartz is used for high transmission of ultraviolet. Such specialized lamps list from $33 for the seven-inch 250-watt UA-2 to $60 for the 50-inch 1400-watt UA-14 lamp. The latter is in half-inch quartz tubing. The air- or water-cooled 1000-watt H-6 mercury lamp has a quartz arc tube only 3¼ inches long, one-quarter inch in diameter and operates at a vapor pressure 110 atmospheres — that is, over 1600 pounds per square inch.



NEW 500-watt infrared heat lamp. Such lamps use a tungsten filament inside the translucent quartz tube. The rating is 100 watts per running inch of filament.

TRANSMISSION characteristics. Transmission efficiency is demonstrated dramatically (above). With one end of a quartz rod in a furnace, a cigarette may be lighted at the other end while the rod is held in the bare hand without discomfort.

TRANSMISSION characteristics of quartz and various glasses (below). Quartz has a higher transmission of radiant energy than any other common material. The transmission characteristics are shown here in curve form, for ultraviolet and infrared radiation. Data furnished by the Research Laboratory, Corning Glass Works; the National Bureau of Standards, and the General Electric Lamp Development Laboratory.

Filament Lamps in Fused Quartz Tubes

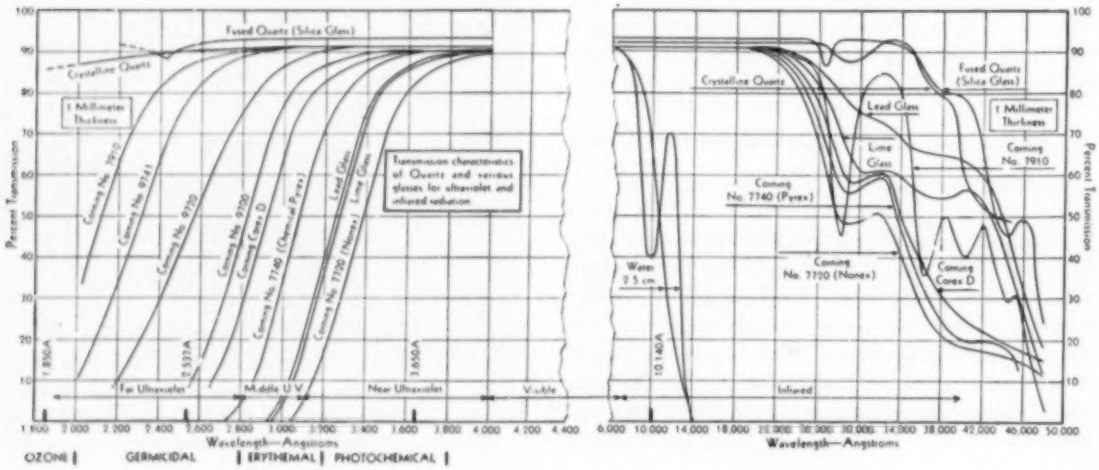
The latest application of quartz tubing for lamps is the new filament lamps recently announced for infrared heating applications. In these lamps a coiled tungsten filament extends from one end to the other, somewhat like the lumiline lamp but the inside bore of the quartz tubing is less than a quarter inch. The wattage runs 100-watts per inch. (Lumiline lamps in one-inch glass tubing — about three watts per inch.) The quartz tube at this loading gets red hot. Ordinary glass would melt at once. The thermal characteristics of fused quartz are such that you can put ice cubes on the red hot quartz with no more effect than sizzle and steam. The design problem is not with the quartz itself but how to maintain an airtight seal between the metal leads and the quartz through the extreme cold-hot temperature range.

Metal expands under heat many times more than quartz. A flattened metal lead seems to do the job if excessive seal temperatures are avoided. This same sort of problem had to be licked in the early days of filament lamps with ordinary glass bulbs.

Fused Quartz in Non-Lighting Applications

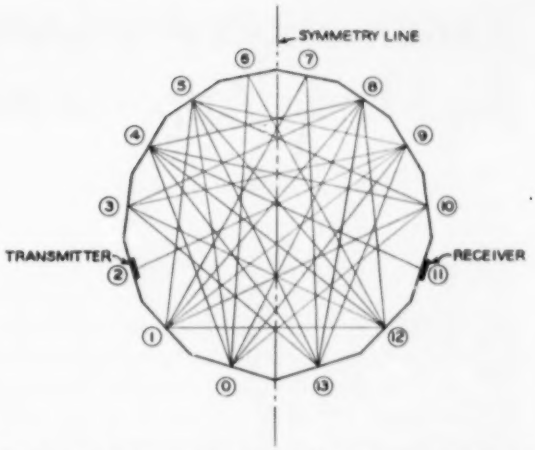
Aside from the use of quartz in lamps, there are many other fascinating uses of quartz where its extraordinary properties make it unique in application.

The chemical and electrical properties have been mentioned as significant in both these fields as specialized precision components. The minimum expansion of quartz under extraordinary temperature changes and its high melting point compared with other materials or metals has inspired many uses. For example, as an immersion tip or enclo-



sure for thermocouples for rapid recording of temperatures of molten steel. Those in the know now cite significant uses of quartz components in radar applications — now that certain publicity restrictions are removed.

One intriguing use of transparent fused quartz disks is in what I would call "delayed electricity." The purpose of this is in the memory schemes used as a part of the various designs of the new "electric brain" computers. If I have gained the slightest suspicion of how quartz serves, my explanation goes something like this. Delayed action of electricity is accomplished by converting electricity into supersonic sound waves. These are passed through a clear fused-quartz disk by many internal reflections from accurately ground faces on the periphery of the disk. By internal reflections, as shown in the sketch, a single 15-inch flat disk is equivalent to a quartz rod 18 feet long, which anyone would agree would be difficult to make and handle. The speed of the supersonic vibrations through the quartz path is only 1/200,000th the speed of electricity — so when these emerge at the last stage and are again converted to electrical energy its electrical effect is delayed beyond the same source of electrical energy which was sent by another circuit to the computer. The time delay is regulated by the distance the supersonic waves traverse the invisible labyrinth of reflection paths through the quartz disk. Precision control demands utmost precision in surface grinding.



DELAYED ELECTRICITY. This is accomplished by sending supersonic waves through an intricate pattern of internal reflections in a clear fused quartz disk.

Speculation on the Future

Glass working is one of the oldest arts, whereas quartz history goes back only about four centuries when the natural rock crystals became known as quartz. The first serious research on fused quartz is scarcely 50 years old. The higher pressure mercury lamps were first marketed in 1934 — only 20 years ago. Many improvements have been made in mercury lamp design during those 20 years.

By using quartz instead of glass as the arc tube for the 400-watt E-1 lamp (introduced in 1947), lumen output was increased from 15,000 to 20,000 lumens. It costs more to make the lamp but the overall cost of light was reduced.

Quartz has been sort of a stubborn and difficult material to process and fabricate. New methods and processes give promise of easier handling and lower production costs. If some of these economic barriers are lowered, there are many ideas being harbored in the minds of those interested in new lamps and lighting devices to insure the business from becoming static for a while at least. Glass technology in recent years has extended glass applications towards the quartz realm functionally. Quartz technology may soon narrow the gap pricewise. Quartz is, as mentioned before, only thoroughbred glass.

[EDITOR'S NOTE: This article is one of a series on the characteristics of materials and services relating to the lighting industry. Previous articles in this series are: "Characteristics of Plastics," December 1951; "Characteristics of Porcelain Enamel," July 1952; "Characteristics of 300-Degree White Baked Enamel Finishes," February 1953; "Characteristics of Alzak Aluminum," March 1953; "UL — and the Lighting Industry," July 1953; "Characteristics of Tungsten," August 1953; "Calculating Sound-Absorbing Effect of Acoustical Baffles in Lighting Systems," September 1953; "Characteristics of Phosphors," May 1954; "Characteristics of Lighting Glassware," June 1954; "Characteristics of Mercury," July 1954. Future articles are planned on the rare gases, and more on plastics.]

Report on the Conference

A full report on the I.E.S. National Technical Conference, held September 13-17 in Atlantic City, New Jersey, begins on page 5A of this issue.

Xenon Short Arc Lamps And Their Application

By WOLFGANG E. THOURET
GEORGE W. GERUNG

Because of the limited brightness of incandescent lamps for optical devices there is a definite demand for light sources combining the high brightness of carbon arcs with the maintenance-free operation of filament lamps. Xenon high pressure short arc lamps, a result of recent research and development work in Europe and in this country, seem to be an answer to this problem. Data are presented of four new types of these lamps. Their electrical and optical characteristics, certain design features and the possibilities of application in the fields of optical devices and projection systems are analyzed.

BECAUSE OF the limited brightness of incandescent lamps for optical devices, there is a definite demand for light sources combining the high brightness of carbon arcs with the maintenance-free operation of filament lamps. Mercury and xenon short arc lamps, characterized by operation at high wattages per unit arc length up to 2 kw/mm and at high pressures up to 65 atmospheres, seem to be an answer to this problem. They have high luminous efficiencies and high brightness values that otherwise can be produced only by carbon arc lamps. It is their advantage, however, that they are perfectly clean in operation and that their arcs operate steadily without attention over a long life, as they are completely enclosed and hermetically sealed in a bulb.

Mercury short arc lamps have been developed since 1936[1-11] and have been available as special high brightness sources for many years. During the last war, rare gas arc discharges were investigated under the operating conditions of short arc lamps by Schulz.[12-14] His results showed that short arc lamps filled with krypton or xenon gas represent light sources of high brightness which have two important advantages over mercury short arc lamps: perfect color rendition as in natural sunlight (due to a virtually continuous spectrum in the visible and ultraviolet) and undelayed full light output after being switched on. The luminous efficiency of krypton or xenon short arc lamps and their brightness amount only to approximately 50 per cent of those of mercury lamps under equal conditions. However, considering the above advantages, these values are still high enough to justify great interest in the development of rare gas lamps as new high brightness sources for use in projectors, searchlights, and other optical devices. Besides this, the high pressure rare gas discharges have a strong emission in the ultraviolet and near-infrared.

Therefore, confirming and extending the original results of Schulz, several other authors have done research work on the physical properties of arc discharges in the heavy rare gases and data of a number of experimental xenon high pressure lamp types have been published. Aldington[15] and Cumming[18] mainly investigated long arc xenon lamps operating in the pressure range of 1 or 2 atmospheres at approximately 100 to 1000 watts per centimeter arc length at lamp wattages from 1 to 5 kw with arc lengths between 30 and 85 mm. These lamps are characterized by their daylight color rendition and a luminous efficiency between 24 and 30 lumens per watt. The larger wattage types require water cooling. As their principal application, the authors mention photographic, motion picture, and television studio illumination. The brightness of these long arc xenon lamps is relatively low, in the range of 10 to 50 cd/mm^2. The same authors report on the investigation of short arc type xenon lamps with operating pressures limited to approximately 2 atmospheres and with peak brightness of 100 to 200 cd/mm^2. Larché, Ittig, and Michalk[16,19] have described short arc xenon lamps and water-cooled long arc xenon lamps in several papers. Their main long arc types are 6 kw lamps with an efficiency of 37 lumens per watt and a brightness of 30 cd/mm^2 for stage, motion picture and television studio illumination. Most of their short arc xenon lamps are for d-c operation in the wattage

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 13-17, 1954, Atlantic City, New Jersey. AUTHORS: Westinghouse Electric Corp., Bloomfield, N. J.

range between 100 and 3500 watts. They have relatively high brightness between 250 and 1500 cd/mm^2. The luminous efficiency of these lamps ranges from 6 lumens per watt for a 100-watt lamp (due to extremely small electrode spacing) to the remarkably high value of 45 lumens per watt for a 3.5 kw unit. Anderson[17] studied the properties of both mercury and xenon short arc lamps by using the same lamp designs with different fillings and especially investigated the factors influencing the arc stability in xenon lamps. He mentions lamps with wattages between 150 and 700 watts, luminous efficiencies from 18 to 35 lumens per watt and brightness in the range of 100 to 200 cd/mm^2. Baum and Dunkelman[20] investigated the ultraviolet radiation of xenon short arc lamps furnished by Schulz and found that the spectrum is a smooth continuum from 4000Å to 2200Å, where the quartz absorption begins. According to their report the xenon arc ultraviolet radiance exceeds that of conventional hydrogen arcs and that of the carbon crater at least by the factor 10 and compares favorably with the ultraviolet intensity of mercury high brightness lamps.

The purpose of this paper is to report on the development of four new xenon short arc lamp types and to discuss their data and their possible applications. Fig. 1 shows the outward appearance of the lamps and Table I gives their electrical and optical data and their dimensions. All four types are designed for a-c operation only. Xenon short arc lamps for d-c can be designed without major difficulties. Their electrodes would have to be of different size. The wattages from 150 to 2000 cover a relatively wide range in order to facilitate investigation of a great variety of applications.

The low arc voltages in the order of only 20 volts are characteristic for all rare gas short arc lamps. They are a consequence of the very low voltage gradient in the rare gas discharge column which amounts only to approximately one-fourth or one-fifth of the corresponding values in the mercury arc. The low voltage gradient is a main reason for the relatively low luminous efficiency of xenon short arc lamps as the electrode losses amount to approximately 10 or 12 volts and, therefore, represent a considerable part of the entire lamp voltage. The luminous efficiency of the xenon arc column itself is not much lower than that of the mercury arc at equal pressures and wattages per unit arc length.

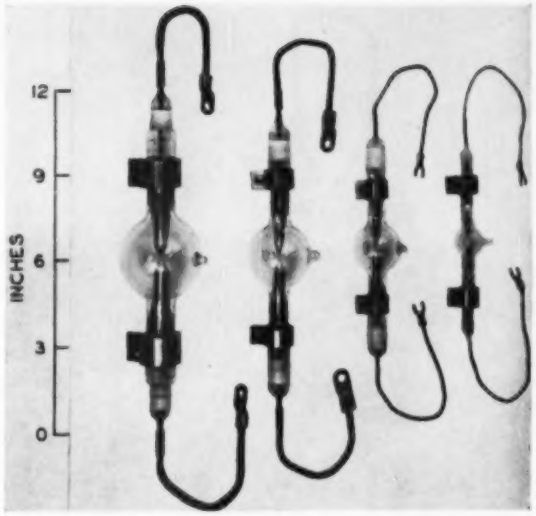


Figure 1. Four types of xenon short arc lamps for a-c operation. From left to right: 2000-, 1000-, 500- and 150-watt.

Table I shows that the luminous efficiency of the four lamp types discussed lies between 16 and 22 lumens per watt. These efficiency values are similar to those of incandescent filament lamps and are not representative of the maximum lumen output that can be attained with xenon arcs. They result from the necessary compromise between source concentration and efficiency that is characteristic of the design of short arc lamps. The combined requirements of compact source dimensions, arc stability, and safe operation call for short arcs and low operating pressures, which result in low arc voltages. High luminous efficiency, however, as explained above, is favored by greater values of arc voltage and, therefore, requires wider electrode spacing and high pressures.

TABLE I.—Approximate Operating Characteristics of Four Types of Xenon Short Arc Lamps for a-c Operation.

Wattage	150	500	1000	2000
Arc Voltage	20-24	16-22	16-22	16-22
Arc Current (Amps.)	7-9	25-32	50-64	100-125
Arc Length (Millimeters)	2-3	2.3-3.3	2.3-3.3	3-4
Arc Width at 10% of Axial Brightness (Millimeters)	1.6	2.6	3.0	4.2
Axial Brightness in Center Between Electrodes (cd/sq. mm)	70	150	250	250
Lumens (Initial)	—	11,000	22,000	32,000
Lumens per Watt	—	22	22	16
Bulb Diameter (Inches)	1	1⅝	2	2¾
Maximum Overall Length (Inches)	6	9	12	13½
Operating Position	Vertical	Vertical	Vertical	Vertical

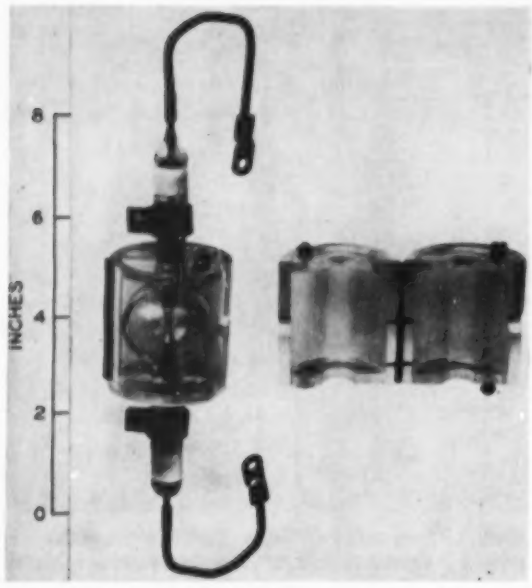


Figure 2. 1000-watt xenon short arc lamp with typical protective handling case.

Another consequence of the low voltage gradient and the resulting low lamp voltages, is the necessity of using relatively high lamp currents. These require both large electrodes and seals of great current carrying capacity. The heat developed by the arc in the electrode increases approximately in a linear relation to the arc current. Therefore, the ability of the electrode to conduct heat away from the electrode tip must increase in proportion to the current. This means that surface area and volume of the electrodes have to be increased considerably with higher lamp wattage, particularly when the lamp voltage remains constant or even decreases when the wattage is increased. Fig. 1 shows the relatively large dimensions of the electrodes which consist of swaged tungsten. The electrodes of the 2000-watt lamp have a diameter of one-half inch. Thus a considerable portion of lumen output of the arc is shadowed off. This condition partly explains the comparatively low luminous efficiency of this lamp type.

As the bulbs of all four lamps consist of pure fused quartz, the design of reliable high current seals presents a problem, especially for the higher wattage types. The well-known molybdenum ribbon seal design is used throughout. The three greater wattage lamps have multiple ribbon seals, consisting of 3, 4 and 6 single ribbons respectively. Life and reliability of the multiple ribbon seals are considerably increased by additional graded glass seals. Thus the connection between the heavy outer tungsten lead wires and the molybdenum ribbons is protected from oxidation.

The quartz bulbs of the four lamps are all of exactly spherical shape for ease in manufacture and in order to obtain the greatest mechanical strength at a given diameter. The bulb loading is considerably lower than that which is usually chosen for mercury short arc lamps because no consideration of a run-up time is required. The filling pressures of the cold lamps range between 45 and 230 pounds per square inch (3 to 15 times atmospheric pressure). During operation the internal pressure increases approximately by a factor of two or three. The safety hazard involved is, however, very small. Violent lamp failures during operation are very unlikely because the average bursting strengths of the lamps are between six and eight times greater than the maximum operating pressures. Nevertheless, in order to avoid any chance of injuring persons, the lamps are always to be operated in a completely enclosed housing. This provision should not restrict the use of the lamps because virtually all possible applications require operation in enclosed devices. In order to eliminate a possible hazard during shipment, storage, or handling of the cold lamps, special protective handling cases are provided, as shown in Fig. 2. These cases are made of transparent plastic material and are so arranged around the bulb that the lamp can be electrically connected and adjusted in the fixture without removing it. They shall be opened and removed only immediately before the lamp is put into operation.

The brightness distribution and the source dimensions, as measured on samples of each type, are

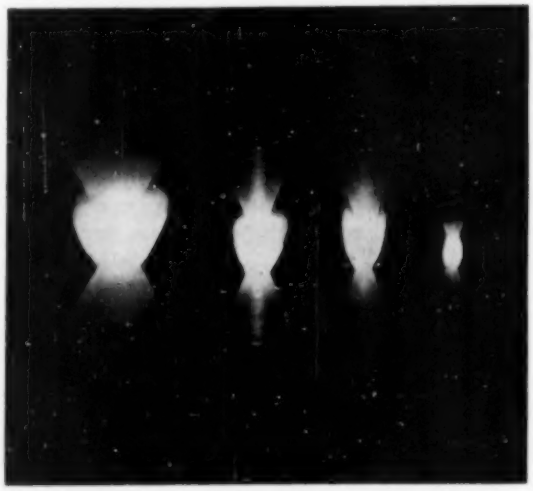


Figure 3. Arcs of the 2000-, 1000-, 500- and 150-watt a-c xenon short arc lamps.

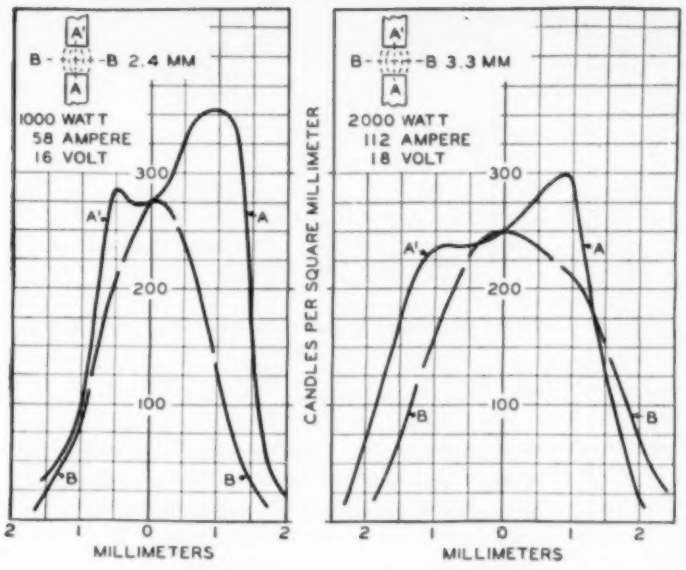


Figure 4. Brightness distribution across the arc of the 1000-watt and the 2000-watt xenon short arc lamps.

shown in Figs. 4, 5 and 6. The first two figures give brightness curves measured along the axis of the arc and across the arc in the center between the two electrods. Fig. 6 shows a complete contour map of curves of equal brightness for the 2000-watt type. All lamps were operated in vertical position during the measurements.

The axial brightness values in the center between both electrodes can be considered to represent each lamp's brightness. They range between 70 and 250 candles per square millimeter. The source dimensions of the 2000-watt lamp are very close to circular or square shape, as illustrated by Fig. 6. This, together with the high intrinsic brightness, is considered ideal for many applications which require a point source because it allows maximum utilization of the light output by the optical system. The smaller wattage types, as shown in Fig. 3, have a lesser degree of source concentration, but the dimensions still seem to be very favorable for numerous optical purposes. The axial brightness curves of all lamps show a more or less pronounced peak close to the bottom electrode. This is the consequence of a considerable difference in the operating temperatures of both electrodes. The degree of arc constriction at the tip of an electrode is a function of its operating temperature. Therefore, the arc column constricts itself much more at

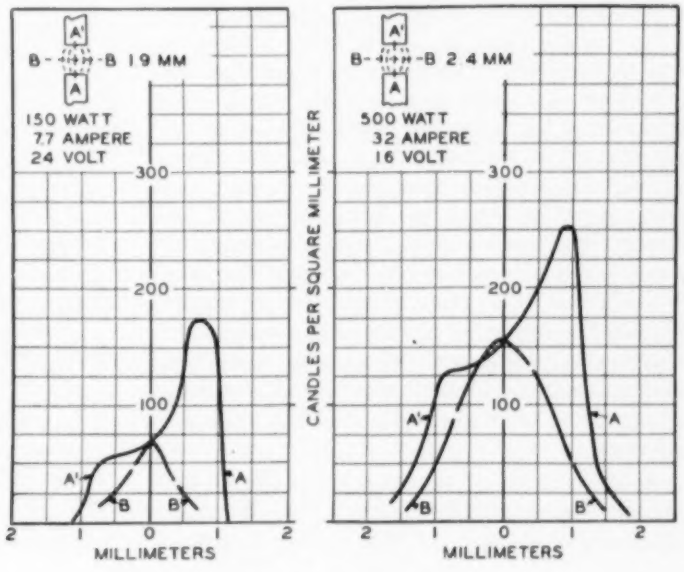


Figure 5. Brightness distribution across the arc of the 150-watt and the 560-watt xenon short arc lamps.

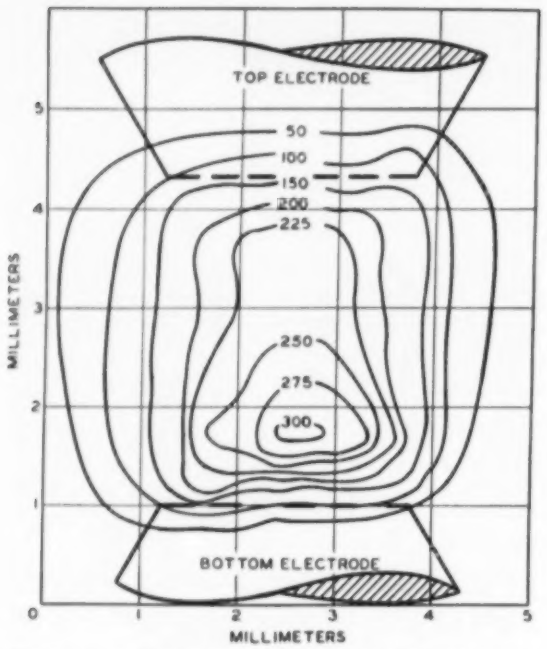


Figure 6. Arc brightness distribution of 2000-watt xenon short arc lamp. Contour lines in candles per square millimeter.

the tip of the relatively cool bottom electrode than it does in the neighborhood of the top electrode. The latter is heated to a considerably higher temperature by the hot upward flowing gas from the arc column. This effect is not observed when the lamps are operated in horizontal position.

The lamps can be operated from a standard 120-volt a-c supply, using a series inductance or resistance ballast. In addition, a special high voltage pulse starting circuit is required, as the breakdown voltage of the lamps lies in the range between 10 and 50 kilovolts. A suitable circuit arrangement, consisting of a spark gap oscillator and a pulse transformer has been described by Freeman[10] for the purpose of starting mercury short arc lamps under full operating pressure. A typical xenon lamp operating circuit is shown in Fig. 7. As already mentioned above, a main advantage of xenon lamps over mercury lamps is that they have virtually full light output immediately after starting. In the moment of starting, the luminous flux amounts to approximately 80 per cent of the peak output which is reached after several minutes, when the bulb is warmed up to full operating pressure.

As shown in Fig. 1, the lamps are equipped with simple mounting collars for fastening them mechanically in the fixture. This method of holding

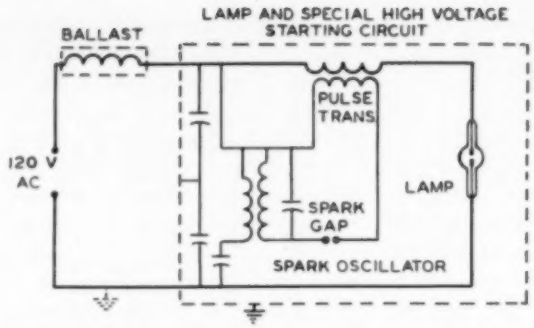


Figure 7. Typical operating circuit for xenon short arc lamps.

is in use for several short arc mercury and mercury xenon lamp types. It has certain advantages because it lends itself to accurate light center adjustment and rugged, shock-resistant mounting. The electrical connections are made separately through flexible leads with standard lugs.

The spectral energy distribution of the xenon lamps follows very closely to the spectral energy of sun plus skylight in both the visible[21] and ultraviolet[22] range. See Fig. 8. To further illustrate the spectral energy qualities of the xenon lamp, it is compared on an equal energy basis over six bands of the visible portion of the spectrum to sun plus skylight,[21] along with Illuminant C,[22] direct sunlight,[21] the fluorescent cool white deluxe lamp and the incandescent 500-watt general service lamp. See Table II. This analysis demonstrates

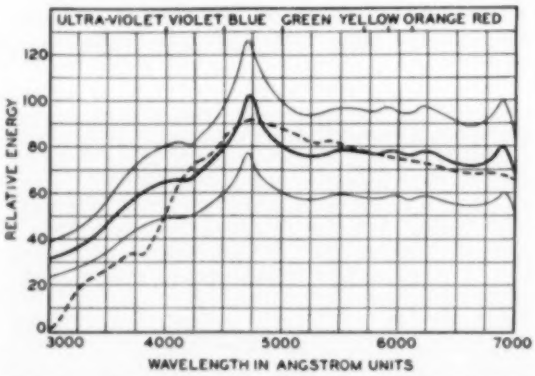


Figure 8. Spectral energy distribution of the 500-watt xenon short arc lamp between 3000 and 7000 Å.

Heavy solid line: Radiation from 500-watt xenon short arc lamp at rated wattage.

Dotted line: Spectral Energy Distribution of the Sun plus Skylight on a horizontal plane. Ordinates are proportioned to give the same amount of energy as the 500-watt short arc lamp in the visible range.

Light solid lines: Radiation from 500-watt xenon short arc lamp operated at 25 per cent over and under rated wattage.

TABLE II.—A Comparison on an Equal Energy Basis of the Visible Spectrum of Various Sources to the Spectrum of Sun Plus Skylight.

VISIBLE SPECTRUM		AVERAGE LEVEL OF ENERGY											
		Sun Plus Skylight		Short Arc Xenon		Illuminant "C"		Direct Sunlight		Cool White DeLuxe Fluorescent		General Service 500-Watt Incandescent	
			Δ		Δ		Δ		Δ		Δ		Δ
Six Bands	Ångstroms												
Violet	4000-4500	15.3	—	15.1	0.2	16.7	1.4	13.1	2.2	12.1	3.2	4.6	10.7
Blue	4500-5000	18.9	—	18.5	0.4	20.2	1.3	17.5	1.4	10.7	8.2	8.7	10.2
Green	5000-5700	17.8	—	16.7	1.1	17.2	0.6	18.0	0.2	17.1	0.7	15.0	2.8
Yellow	5700-5900	16.9	—	16.9	0.0	16.5	0.4	17.8	0.9	24.6	7.7	20.3	3.4
Orange	5900-6100	16.1	—	16.8	0.7	15.1	1.0	17.3	1.2	23.4	7.3	22.7	6.6
Red	6100-7000	15.0	—	16.0	1.0	14.3	0.7	16.3	1.3	12.1	2.9	28.7	13.7
$\Sigma\Delta$			—		3.4		5.4		7.2		30.0		47.4

Δ — Deviation from sun plus skylight.
$\Sigma\Delta$ — Sum of the deviation from sun plus skylight.

that over the visible spectrum, the average level of energy of the xenon short arc lamp deviates a sum total of only 3.4 units from the visible spectrum of sun plus skylight and on the same basis, Illuminant C is its nearest competitor with a total variation of 5.4 units while the incandescent 500-watt general service lamp represents a total difference of 47.4 units. Along with its excellent spectrum, the xenon lamp has the ability, for all practical purposes, to retain its relative spectral energy distribution despite a 25 per cent variation in wattage or light output. See Fig. 8.

Despite the xenon lamp's useful properties, there is always the practical question of whether the lamps will be sufficiently economic to warrant their use. It is generally realized that these lamps entail a basically high material and manufacturing cost. These can be attributed directly to the high cost of the quartz bulb and xenon gas, as well as to the amount of skilled labor required in manufacture. These factors and the outlook of no substantial immediate reduction in their total cost lead to the necessity of developing long-life xenon lamps.

As yet, there is insufficient manufacturing and life testing experience to warrant the establishment of definite life ratings. However, there are reasons to assume that in the course of further development the xenon lamps will attain life ratings between several hundred and one thousand hours. This assumption is based on the nature of the xenon lamp's special operating characteristics which are different from those of high pressure mercury lamps. Xenon lamps do not require a warm up time. The electrodes always operate under relatively high pressure which minimizes bulb blackening. The continuous high pressure in xenon lamps also eliminates the necessity for high warm up currents which overload the electrodes and increase their evaporation rate. In addition, considerably larger bulbs can be used, which offer a greater area for depositing the blackening material which evaporates from the electrodes.

The advent of a line of xenon short arc lamps will offer the opportunity of extended investigation into numerous avenues of application in the fields of still and motion picture projection, searchlights, spotlights and back projectors for theatrical and television studio lighting, color matching, solaria and accelerated fading or aging tests.

Probably the most promising field for xenon lamps is in their application for motion picture projection where, as presented by D'Arcy and Seda,[23] it not only utilizes the obvious features mentioned previously, but also takes advantage of the lamp's alternating current characteristic which allows the lamp to be pulsed. This method of operation provides for the movement of the film between light pulses eliminating the use of the projector's standard shutter. This eliminates the shutter loss and results in a sizable gain in the screen lumens which is so necessary for new large screens.

In still picture projection there is always need for more screen lumens and a better color from a bulb type light source. To meet this need, the xenon short arc lamps demonstrate that they can supply a higher brightness in a smaller source. This will enable existing and new optical systems to use a higher wattage lamp and obtain an increase in screen lumens. The xenon arc also has the advantages of being enclosed in a bulb like the incandescent lamp with no moving parts and it has a daylight color of light.

Spotlights for theatrical and television studio lighting will welcome the xenon lamp. Its combined properties of a balanced daylight spectrum, high efficiency and flickerless light will provide more brilliant illumination and will permit wide control without color fringes. It also presents the opportunity of utilizing the full color spectrum by filtering for special effects.

Based on its daylight color characteristics, a xenon lamp should present a practical high-efficiency color matching standard, eliminating the use of inefficient filters, the problems of mixing of sources, and providing a source whose spectrum is constant throughout life and independent of variations in supply voltage.

The xenon lamp will receive consideration in accelerated fading and aging tests which would welcome a bulb type source of adequate power with a minimum of maintenance and a close approximation of solar energy. The fact that the xenon lamp has an excess of ultraviolet energy can be used to advantage by speeding up exposure time, or it can be filtered out as required. These same characteristics would be valuable for solarium units when long-life lamps are available to produce indoor sunlight in large areas or in concentrated form.

It is believed the basic properties and some of the possible applications of the xenon lamp which have been presented will establish it as a significant new lighting tool and a lamp with a future.

The authors gratefully acknowledge the cooperation of Miss P. Presbrey and Messrs. R. A. Gingras, T. C. Retzer and D. L. Williams.

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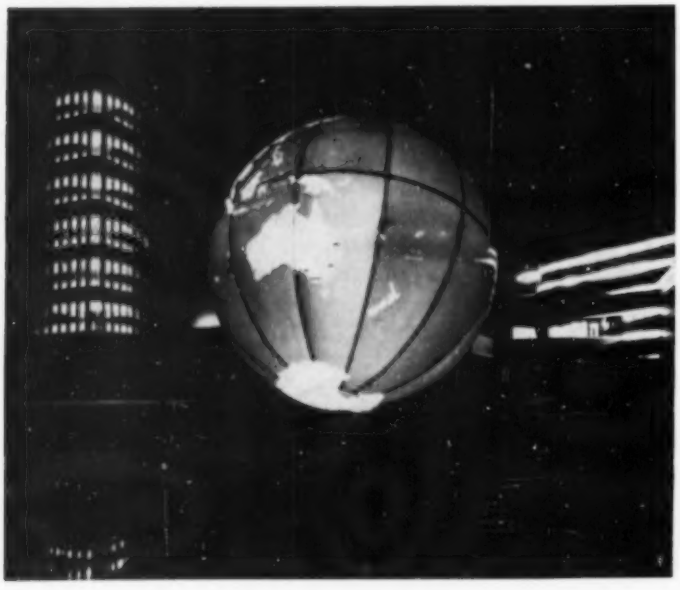

WORLD-WIDE operation of Johnson's Wax products is symbolized by the large globe, 11 feet in diameter, located in a landscaped area near the entrance to the company's administration building, in Racine, Wisc. The globe is lighted at night from the inside by 24 specially-built hairpin-shaped neon tubes which form a ball six feet in diameter. A heating element inside the globe is thermostatically operated whenever the temperature drops below 45 degrees.

With a circumference of 35 feet and a weight of 1700 pounds, the globe has a scale of one inch to 60 miles. Acrylic plastic sections are attached to the steel framework by phosphor bronze, springlike clips which allow for expansion and contraction with temperature variations.

Engineering and construction by Steiner Plastics Co., Glen Cove, N. Y.; electric work by Clarke Sign Co., New York, N. Y.

Determinants of Fluorescent Lamp Life

By RICHARD N. THAYER

THE PURPOSE of this paper is to summarize the effect of design and operating variables on the life of fluorescent lamps. These variables differ widely from those for filament lamps, and much of this information reported here has not previously been published.

Life definition and end-of-life behavior. Metal electrodes are sealed into each end of a tubular fluorescent lamp to conduct the electric current through it. In normal a-c operation, both of these electrodes act alternately as cathodes and anodes many times a second, but they are commonly called cathodes because their chief design requirement is to emit electrons. Each cathode is coated with a white powder of alkaline-earth oxides to provide the required emission current. This material gradually evaporates and sputters away during lamp starting and burning. When it disappears completely from either cathode, the lamp is called "deactivated." This constitutes the end of life, and over 99 per cent of all fluorescent lamps end their life in this manner.

The behavior and reliable identification of these deactivated lamps vary with different lamp and circuit types. In switch-start lamps with ordinary starters, such as the glow type, the deactivated lamp end will show heavy blackening all over (Fig. 1, B) in marked contrast to the blackening patterns of still operative lamps (Fig. 1, A). Also, the deactivated end will glow an incandescent yellow color at preheat instead of the usual fluorescent one; and the lamp will light throughout its length only in momentary flashes. If the starter includes a lockout device, it will sometimes cut the lamp out of the circuit shortly before complete deactivation. If this lamp is then tried on another circuit or starter, it may operate a few more hours. This possibility, or the alternative one of sorting out and re-using operative lamps removed in group replacement programs are the only basis we know for claims that lamps removed from fixtures as failures can be "rejuvenated"; *i.e.*, processed so that their life is renewed.[1] Since the emission coating in a deactivated lamp has commonly left the cathode completely and deposited along the bulb wall, no way is apparent to us by which this scattered material can be returned.

With instant-start slimline lamps, the high open-circuit voltages required for reliable starting will still force an arc through the lamp despite deactivation of one cathode. On lag circuits, lamp operation often continues many more hours with a flickering light resulting from the half-wave rectified current produced by one normal and one deactivated cathode. On lead circuits, the series capacitor prevents this rectification. There results instead a highly erratic and flickering discharge which usually lasts only a few minutes. By that time the glass stem at the deactivated end overheats, cracks, and admits air that quenches the discharge. Since operation of deactivated lamps on either circuit usually overloads and overheats the ballast, users should be sure to turn off promptly and replace any lamps showing the heavy blackening at one end typical of deactivation (Fig. 1, B).

In rapid-start lamps and circuits also, heavy blackening at one end commonly indicates deactivation. In this case, the lamp are either fails to strike at all or glows only feebly, and there is no danger of ballast overload.

The gradual deactivation and operating-voltage rise of cold-cathode fluorescent lamps have been separately reported.[2]

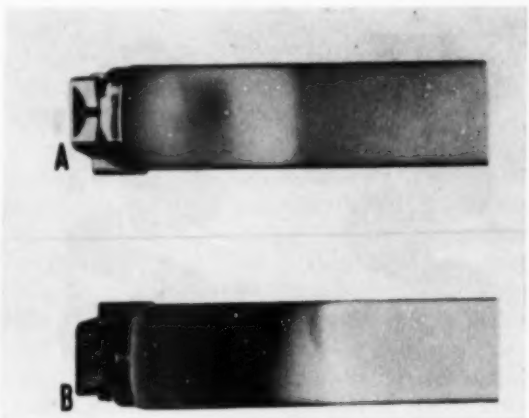

Figure 1. Comparative end-blackening pattern of long-lived operative lamp (A) vs. deactivated lamp (B).

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 13-17, 1954, Atlantic City, N. J. AUTHOR: Lamp Development Laboratory, Lamp Division, General Electric Co., Nela Park, Cleveland, Ohio.

Lamp Design Variables

Cathode and emission coating. Among lamp design variables, these are the prime determinants of lamp life. In switch-start lamps, the cathode is a fine tungsten wire wound into a coiled-coil (Fig. 2, left). This configuration permits putting the required wire length into the available space, and also acts as a "basket" to hold tightly a relatively large quantity of emission coating. The cathodes are coated by dipping them into a liquid suspension containing the emission material. Proper cathode design and processing involve many variables and techniques too detailed for coverage here, except for brief examples.

One is the cathode design for instant-starting lamps, where the cathode undergoes severe bombardment and sputtering of its emission coating at every start because it is not preheated. The life of conventional coiled-coil cathodes is greatly reduced in such service. To obtain normal life, a loose overwind of fine wire must be added to the coiled-coil (Fig. 2, right). This added winding holds the emission coating on more tightly; also, it heats up quickly under bombardment, thereby reaching operating temperature faster and minimizing the loss of sputtered coating. A short-length modification of this same triple-coil design has proved advantageous as the cathode for rapid-start lamps.[3]

Another example is the large life gain obtained by adding a small percentage of zirconium oxide[4] or zirconium metal powder to the emission coating. This addition was an important factor in the industry increase in rated lamp life from 2500 to 7500 hours a few years ago.

A third example is the close proportionality of lamp life to the quantity of emission coating held by the cathode, as shown in Fig. 3. Getting the desired quantity on the cathode, and retaining it there through all lamp processing and handling steps requires close controls, and any errors or omissions can easily result in short-life complaints. One important quality control check is on the weight of emission coating, either on the lamp mounts before sealing into the bulb, or by break-open checks on completed lamps. A novel electronic method has been developed which permits much faster testing and larger samplings on completed lamps without destroying them.[5] In this method (Fig. 4), the lamp under test is compared in a Wheatstone Bridge circuit with a control lamp having an uncoated cathode. When current is passed through the bridge, a momentary unbalance occurs because the coated cathode is slower to increase its temperature and so its hot resistance. The amount of this unbalance is read on a meter, and is roughly proportional to coating weight. This "thermal-inertia" tester has proved a useful control tool in detecting short-life lamps.

Figure 2. Cathode designs: coiled-coil for switch-start lamps (left), and triple-coil construction for instant-start lamps (right). (Before applying emission coating.)

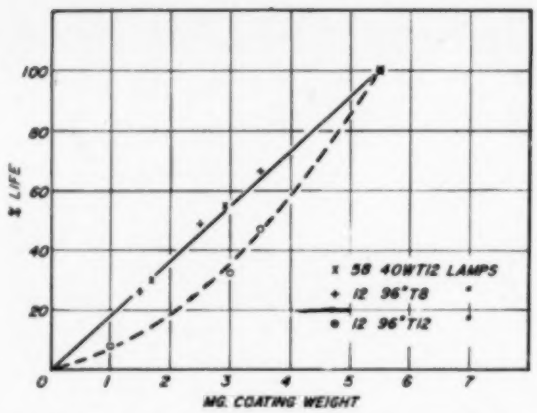

Figure 3. Effect of emission-coating weight on lamp life.

Pressure of starting-gas. Although the high efficiency of the fluorescent lamp depends on the ultraviolet radiation produced when the lamp current passes through mercury vapor, lamps filled only with mercury will not start or operate by practical means. A small amount of inert gas must be added also, and the common choice for most sizes is argon at a pressure of about 3 mm Hg. Fig. 5 shows that lamp life increases sharply with increasing gas pressure; note that our data show a much steeper slope in the 3 mm region than do Lowry's.[6] Higher pressure apparently reduces the rate at which emission coating is lost from the cathode by evaporation and sputtering. The chief disadvantage of higher pressure is harder starting, particularly at

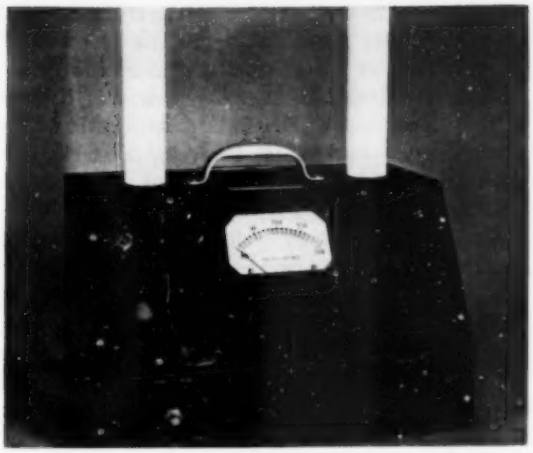

Figure 4. Thermal-inertia tester for non-destructive determination of emission coating weight in completed lamps. Portions of the control lamp and the lamp under test are seen projecting from the tester.

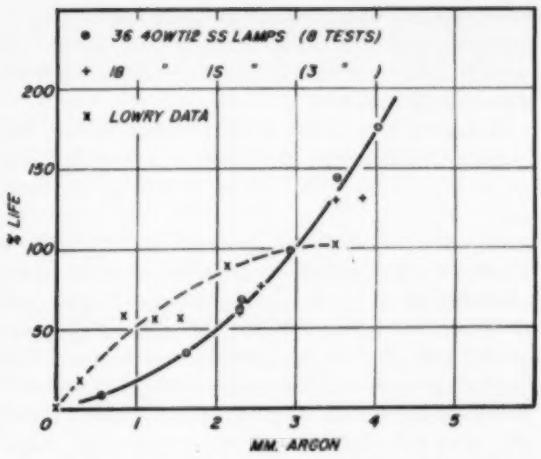

Figure 5. Effect of argon filling-pressure on lamp life.

low ambient temperatures; this in turn requires higher-voltage, more costly ballasts. Another disadvantage is lower luminous efficiency, for lamp volts and watts at a given current rating increase with higher pressure, while light output remains essentially constant. The commercial use of higher pressure, therefore, has been confined to cold-cathode lamp designs[2] and to specialty uses.

Starting-gas pressures below 3 mm increase lamp efficiency and low-temperature starting ease at the expense of shorter lamp life. A commercial example of this is the 40-watt LT (low-temperature) design, which contains 2.5 mm argon. It starts reliably at much lower temperatures than does the standard lamp, but its life rating is only about 60 per cent of the standard. The industry trend over the years has been to reduce filling pressure on standard lamps slightly for these performance advantages, and to compensate for the life reduction by cathode design improvements.

Manufacturing variations produce a ± 0.2 variation of filling pressure in individual lamps. Fig. 5 shows a corresponding life variation of about ± 12 per cent. This trend is confirmed by break-open measurements on large lots of life-tested lamps of standard manufacture. There, lower-pressure lamps average shorter lives than do high-pressure ones.

Lumen maintenance. The progressive decline in light output of fluorescent lamps with continued burning sets a limit to their most economic life, regardless of whether they will continue to operate. The exact value obtained by calculation for this life value depends on the amounts of many parameters — initial lamp and installation costs, annual hours of use, power rates, amortization schedule on fixtures, rate of dirt accumulation and cleaning frequency, etc. The important lamp design variable in such considerations is lumen maintenance. Obviously, the most economic lamp life would be indefinitely long if there were no decline in light output with burning; on the other hand, a steep decline in light output with burning would justify early replacement or a shorter-life lamp design. Along with increasing rated life, lumen maintenance of fluorescent lamps has improved steadily over the years. For typical service and cost conditions now encountered, and with present lumen-maintenance ratings on lamps, the total cost-of-light to the user is very close to the minimum for the present 7500-hour life ratings.

Life Testing Procedures

Methods of standard life testing will be described next, since these are the standard test lots against which various operating and service variables will be compared for life later in the paper.

Life testing objectives. Ideally, the lamp manufacturer's life testing should serve two aims: (1) indicate how much lamp life is varying from time to time, and between various places and conditions of manufacture; (2) indicate what lamp life customers will obtain in service. The testing procedure and program must be well-planned to meet both aims. To meet the first, a constant base-line of testing conditions, such as starter and ballast designs, must be held over a long period. To meet the second, testing conditions must be shifted as fast as predominant customer usage shifts. To provide the continuity needed for the first aim, the base-line condition must necessarily lag new commercial

developments used in field operation. So, duplicate lamp samples are often life-tested on these new developments to determine any life variations from the existing standard.

A review of our starter and ballast choices for standard testing over the years will illustrate the problems encountered and their manner of solution.

Starters for standard life testing. When both magnetic and thermal starters were commercially available in early years, the magnetic type was used for life testing. When the glow starter displaced both of these in customer use, its use in life testing became and remains standard. All glow starters used for life testing are individually tested for conformance to industry performance standards, and are group replaced at two-year intervals. The 100-watt T17 lamp (now largely replaced by the 90-watt) was used with four-contact thermal starters when first introduced, and so was life tested the same way. During the war, glow-switch starting became predominant, and the corresponding shift in standard testing was made after the war. Lamp test life shifted considerably, and required lamp redesign to meet published and test levels obtained with thermal starters.

Ballasts for standard life testing. For the first several years the large, low-loss reactors built with integral magnetic starters were used. When they became commercially obsolete, selected samples of commercially popular ballasts were substituted, and are still standard on many lamp sizes. The model of predominant demand is selected; on low-wattage lamps, it is a reactor operating from 118-volt supply; on the higher-wattage lamps operating from stepup voltages built into the ballast, it is a 118-volt input, two-lamp, lead-lag design. To minimize variations in lamp operating current at life testing, only those individual ballasts are used which deliver within 3 per cent of rated current to reference lamps. Commercial limits are necessarily broader than this, resulting in occasional difficulty to obtain desired samples.

The newest method, now largely used on high-production types, is to operate lamps from a voltage supply at their rated open-circuit value, through specially constructed, individually adjusted reactors and reactor-capacitor combinations. These can be adjusted and held permanently within 1 per cent of rated current.

Other life testing procedures. Most lamps are burned horizontally on metal-frame racks, at spacings comparable to those used in commercial fixture designs. Until four years ago, the test positions were purposely designed without adjacent metal, to insure that lamps would start reliably under this adverse condition. But laboratory tests then showed that the greater performance problem (for switch-start lamps) is instant-starting under favorable starting conditions. For this reason, and because of the dependence of Dri-Film coated instant-start lamps on adjacent metal for reliable starting, a grounded metal backing simulating a fixture is now standard for all lamp types.

The standard testing cycle is 180 minutes on, 20 minutes off for all lamp sizes. Duplicate lamp samples are frequently tested at certain other starting frequencies for comparison with the standard cycle.

The supply voltage is sinusoidal a-c, controlled to 1.5 per cent of rated value.

Lamps are removed from the test positions only for photometry intervals, at 500, 3000, and 7500 hours.

Lamp samplings are obtained from each factory for each month, and are randomized to represent the whole month, and not just production for a particular day.

Life test results and comments. Test results obtained by the above methods are combined with our information on common service conditions to determine our published life ratings.

Considerable time is required to determine lamp life. Although a year has 8760 hours, it takes 1½-2 years to run a lamp lot averaging 7500 hours life. This is because the last individual failure often runs to 10,000-12,000 hours; besides this, there are the delays of shipment and handling, cycling time off, removal for photometric intervals, etc. Even when lamps are somewhat short-lived, the first failures would occur fully six months to a year after manufacture, when the lamps represented are already in service use. No completely reliable method has been found to date that will substantially accelerate life testing of fluorescent lamps. So, the lamp manufacturer's chief control over lamp life is vigilant attention in daily production to all the design and process variables that affect it.

The spread of individual lamp lives from the average of the group has commonly been shown in the lamp industry by a mortality curve which shows percent of lamps surviving at various percentages of rated life. Where the distribution of values follows a normal probability curve, as it usually does for lamp life, a single statistical figure, the standard deviation (commonly denoted as σ), fully describes this spread. High-production fluorescent lamp types have commonly shown a σ of about 25 per cent, which is 1900 hours on a 7500-hour base. Statistical tables will then indicate what per cent of the product may be expected to fall within various coefficients of σ; *e.g.*, 68 per cent

within $\pm 1\sigma$. So, on a 40-watt switch-start lamp, 68 per cent of the lamps may be expected to fail within the limits of 5600-9400 hours. The other 32 per cent are outside these limits, half on the short side and half on the long. Similar calculations may be made for $\pm 2\sigma$, which includes 95 per cent of the product.

This same measure can be used to determine the reliability of test life values obtained on small numbers of lamps. If a group of six lamps is tested, the σ of the average life is the above value divided by the square root of the number of lamps tested. So, life values obtained by testing 40-watt lamp lots in lots of six each have a σ of 10 per cent, or 750 hours. Statisticians commonly require that a test comparison show a difference of 2σ for reliability. So, a six-lamp test of some new ballast or starter design against a six-lamp control lot should show 1500 hours difference before *any* significant difference in accessory effect on lamp life can be indicated.

Service tests of lamp life by large users often involve large quantities of lamps, sometimes exceeding the life-test rack capacity of the lamp manufacturer. So, lamp manufacturers welcome accurate service life information from large users as a supplement to their own test results. However, these tests lack the control over operating variables that rack tests have, and are likely to be representative only of a particularly lamp production date and factory rather than of the total product.

From all this, it can easily be seen that a starter or ballast manufacturer can design and market some new design faster than the lamp manufacturer can reliably determine its effect on lamp life. Both the problems of long test time and limited lamp sampling are involved. On several occasions, the second or third test comparison on some new accessory has yielded a widely different result than the first one. So starter and ballast manufacturers should allow adequate time on their development schedule for the full testing of any design shift which may affect lamp life.

Operating and Service Variables

Many variations in operating and service conditions affect lamp life markedly. Some of these, such as supply-line voltage and starting frequency, vary with each installation, and are often under the user's control. On the two important variables of starters and ballasts, however, the only control the customer has, other than the certification programs mentioned below, is his selection of brand-name and general type of design. On ballasts particularly, his final choice of quality and resulting lamp performance is made when he purchases his fixtures for initial installation. His knowledge of how they affect lamp performance is limited, and he seldom has the facilities required for reliable testing. To aid him in the selection of accessories to provide rated lamp life and other lamp performance ratings, various specification and certification programs have been set up in the industry, concerning which details are available. From the lamp performance standpoint, it is important to emphasize that the precise specification point dividing acceptable from unacceptable accessories is necessarily arbitrary. As later graphs will show, lamp life gradually declines with increasing departures from ideal values. So, even within specification limits, there can easily be variations in lamp life and performance for accessories of differing designs. The lamp manufacturer aims to provide rated life for all accessories meeting specification limits, but still longer life may be obtained with more conservative designs than these. While these specifications summarize at any time the best knowledge to date on requirements for rated lamp performance, they are by no means a closed book. Each year brings some new information which revises older data and concepts, and specifications are then revised accordingly.

Supply-line voltage and lamp current. Lamp life is determined by the cathode, and it is a current-rated device. Those service conditions that increase lamp current usually shorten life, and vice versa. Fig. 6 shows test results on two .43-amp rated lamp sizes, the 40-watt switch-start and the 96T12 instant-start. Test points are not shown because the curves were drawn from a large number of separate tests. Life does not decline as steeply with increasing current on the 96T12 as on the 40-watt because the triple-wound cathode used in the for-

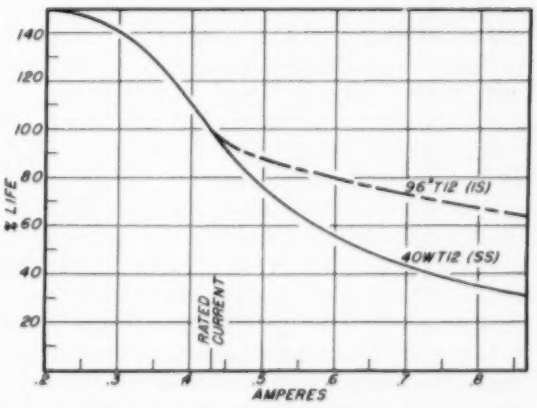

Figure 6. Effect of lamp operating current on lamp life.

mer runs cooler at rated operating current, and so withstands overload better. For it, the curve shows about 0.5 per cent loss in life for each 1 per cent current increase, while the 40-watt shows about 1.7 per cent. Both show increasing life for subnormal current down to about .20 amp. Below there, the life curve turns downward because this cathode size is not adequately heated by lower currents.

One common cause of lamp operation off rated current is line voltages above or below the usual 118-volt ballast design center. On lag circuits, a 1 per cent shift in line voltage causes a 1½-2 per cent shift in lamp current, the exact value depending on lamp size and ballast design. On all lead circuits, each 1 per cent shift in line voltage causes 1 per cent shift in lamp current. A second cause of operation outside rated current is the variation of individual ballasts because of manufacturing variations. A third cause is variation in voltage of individual lamps, for the same reason. A fourth cause follows in the next paragraph.

Lamp-current waveshape. Fig. 7 shows from extensive testing the gradual loss in lamp life as operating-current waveshape increases over the 1.4 crest factor of a pure sine wave. Since lamp wattage was held constant in these tests, the loss of life shown is a compound effect resulting from both (1) the effect of the increasing rms current required to maintain rated lamp watts (see above paragraph) and (2) increased cathode sputtering from peak currents, as compared with lower ones for normal waveshapes of the same rms value.

Line supplies except 60-cycle a-c. Test data are meager because of the overwhelming predominance of 60-cycle supply usage. Preliminary life test comparisons to date in the 360-400 cycle range have been inconclusive because of other variables, and more tests are in progress. Lamp life may be longer at the higher frequencies. Several tests run to compare lamps at equal wattage on d-c vs. 60-cycle a-c showed equal or longer life to cathode deactivation on d-c. In d-c operation, however, starting reliability and drift of mercury vapor to the cathode end are more serious limitations to satisfactory service life than is deactivation.

Ambient temperature. Two life test comparisons have been run. One was of 15-watt T8 lamps in a walk-in cooler held at 32°F. The second was of 40-watt switch-start lamps in a regular life-test room, which runs quite warm because of the high wattage dissipation, vs. control lamps in a room held at 80°F. Neither test showed statistically significant effects on lamp life, and none would be expected over the relatively narrow range of bulb temperatures at which lamps must operate to maintain satisfactory light output.

Starting frequency. Fig. 8 conveniently summarizes on a log-log scale a large amount of data. Ours agree satisfactorily with the Vorlander-Raddin data,[7] which are also shown. On the commonly published life ratios for 6- and 12-hour burning vs. the standard 3-hour, considerable shift in test results has occurred from time to time with no obvious cause.

Cathode preheat (switch-start lamps). The importance of adequate cathode preheat temperature at starting, to obtain maximum life on switch-start lamps has already been reported.[8] Present specification limits for minimum acceptable preheat time and current are based on a minimum permitted cathode temperature of 800K, which is barely perceptible incandescence. Considerably longer life will be realized if each start has ideal preheat; *i.e.*, one in which a fluorescent glow commonly called "end-glow" appears at each lamp end before the

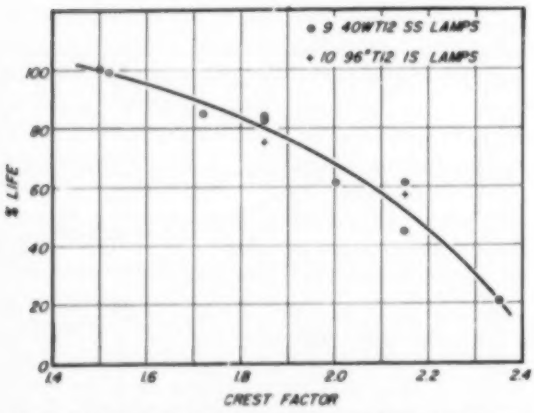

Figure 7. Effect of waveshape of lamp operating current on lamp life. (Lamp wattage was held constant. Crest factor is ratio of peak to rms current.)

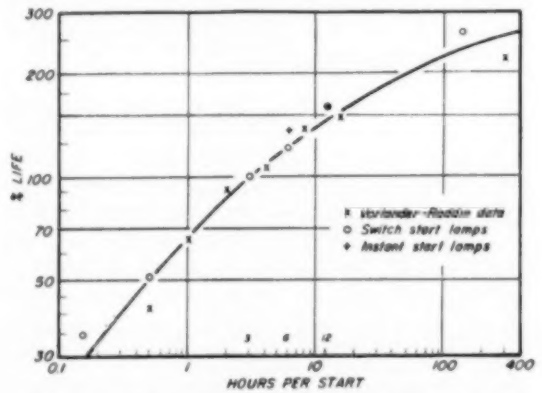

Figure 8. Effect of starting frequency on lamp life.

main arc strikes. The worst preheat condition, of course, is starting without any preheat (instant-starting). The next several topics deal with service variables that affect cathode preheat.

Thermal vs. glow starters. All our comparison tests were run years ago on the four-contact thermal design, when it had considerable use. Because of lamp design changes since, the detail data are no longer dependable, but they all showed a lamp-life advantage for this design of thermal starter. The main reason is that preheat times can be set to ideal values in this design by properly setting contact pressure. A second reason is that no service conditions can cause damaging instant-starting, because the open-circuit voltage of the ballast is short-circuited until cathode preheat is available. Glow starters show some variability in preheat time, and their normally-open contact design sometimes permits instant-starting.

Glow starters have generally replaced thermal starters in market competition because many glow-starter advantages outweigh this life differential. Some of these are lower cost; ruggedness; durability; easier adaptability to reliable cutout designs; no wattage loss during lamp operation; prompt restart; and smaller physical size than some thermals, such as the one tested above.

Instant-starting tendencies on lead circuits. The economical combination of lag and lead circuits in two-lamp ballasts to provide high power-factor has been an immense factor in the acceptance and growth of fluorescent lighting. In addition, lead circuits are better than lag for regulation (see above), and for reliable starting. However, they also show a tendency, under certain conditions, to instant-start lamps in switch-start circuits with resultant adverse affects on lamp life. Fig. 9 shows the direct relation between relative lamp life and

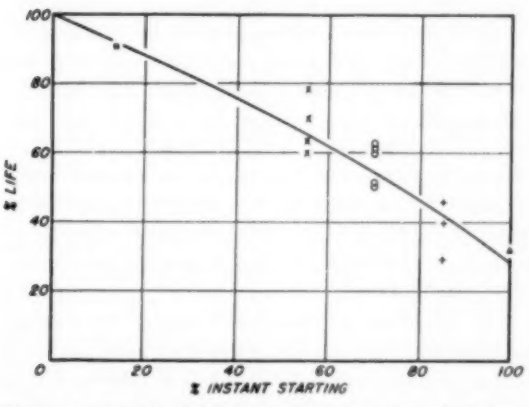

Figure 9. Effect of instant-starting on life of 40-watt switch-start lamps.

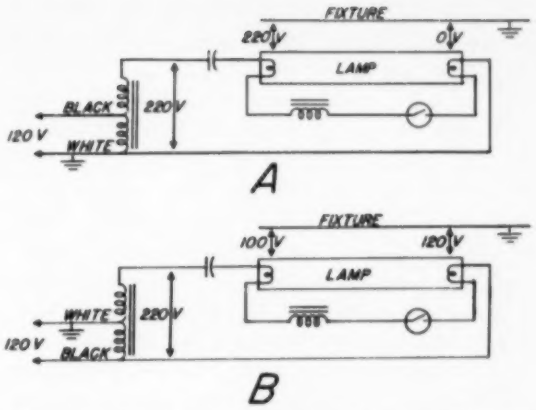

Figure 10. Effect of reversing ground connection and color-coding of 120-volt ballast primary, on potentials between grounded fixture and lamp cathodes. A, former common practice; B, recently recommended practice.

the percentage of starts that occur without awaiting cathode preheat. The 33 per cent life point for 100 per cent instant-starting was obtained by purposely running 40-watt switch-start lamps on instant-start ballasts. The points ranging from 55 per cent to 85 per cent instant-starts, however, were all obtained on lead circuits of commercial ballast designs in tests duplicating service conditions. The point at about 15 per cent instant-starts, with a corresponding relative life of about 90 per cent, is the condition found on our standard test racks. Since lag circuits have not shown this instant-start tendency or life reduction, these relative life figures also represent ratios of lead-to-lag life. Evidence of this problem has chiefly appeared in recent years, and it is still uncertain how widespread its occurrence is, and why some installations, such as the standard test racks, differ so widely from others. A contributing cause to the problem is believed to be the easier instant-starting of lamps resulting from some of the same design and processing improvements that have so steadily improved lamp efficiency and light output over the past several years. Also, laboratory investigation has shown that several or all of the following conditions are required to obtain and study this instant-starting: (1) well-seasoned lamps, such as 100 hours or more burning; (2) burning of test lamps several hours between each successive starting test; (3) adjacent metal of favorable potential, such as occurs in service when both the fixture and the common ballast lead are grounded (Fig. 10, A); and (4) relative humidity below 65-70 per cent, a common occurrence for many locations and times of year. All these factors can easily occur in normal service.

Certain contributing causes and partial remedies are definitely known. One contributing cause is a type of ballast design which came into wide use after the war, in which the rms open-circuit voltage was in the normal range, but the peak voltage was high because of wave distortion. Up to that time, no specification need had been evident for a maximum voltage limit, since economics had always held ballast designs close to the minimum limits. From this experience, a maximum permitted value of peak open-circuit voltage has been set, which reduces but does not eliminate the problem. Another contributing cause, as noted above, and shown in Fig. 10, A is the high voltage existing between one cathode and the adjacent metal fixture under former standard wiring procedures. The shift in primary color-coding and grounding of Fig. 10, B has been recommended, and already adopted by most ballast manufacturers. It reduces the lamp-to-fixture potential available to initiate instant-starting from 220v to 120v, and also shows a definite improvement, though again not a complete cure, for instant-starting tendencies. Obviously, this improvement is not applicable where high open-circuit voltages, such as 236v and 265v, are directly available from line supplies. Nor is either of the above improvements feasible for application to existing installations. If serious troubles are encountered on them with short lamp-life from instant-starting, one possibility is the substitution of normally-closed-contact thermal starters for normally-open-contact glow starters. But then, as was listed above, many inherent advantages of glow-switch design and performance are sacrificed. Besides this open-contact design feature of the glow starter, its glow characteristics are a third contributing cause. It has recently been observed that the glow, which occurs in these starters when the line supply is first turned on, generates transient voltages on the lead circuit during the period required for the contacts to close, and these sometimes produce instant-starting.

Despite these instant-start problems on lead circuits, lamp life averaged for lag and lead circuits should meet published ratings for average service conditions.

Compensated vs. uncompensated lead circuits. Another problem of lead circuits, quite independent of the instant-start problem, is their inadequate current for preheating cathodes unless a compensator winding is added. A previous paper[8] reported 33 per cent loss in life for uncompensated as compared with compensated lead circuits. Three additional test comparisons run since that date, totaling an average of 114 lamps for each lot, average a 30 per cent loss in life for uncompensated lead circuits, in good agreement with previous data. Since this loss of life is additive to any loss from occasional instant-starting, the use of compensated lead circuits remains an industry specification for obtaining rated lamp life.

Trigger-start circuits. This ballast design is commercially available in low-wattage and circline lamp sizes. It aims to provide fast starting without starters on switch-start lamps, by providing a combination of high open-circuit voltage and high cathode-heating current. The latter automatically cuts back to a low value as soon as the arc strikes. Since the same value of open-circuit voltage required for reliable starting under adverse conditions will instant-start the lamp under favorable conditions, a compromise value must be chosen. Five life-test comparisons on 12-inch circline lamps of switch vs. trigger-starting averaged a 30 per cent loss in life for trigger-start. Despite the life loss, lamps are already so long-lived that this circuit has gained wide acceptance, especially for home use, where quick starting and elimination of starters are so desirable. In certain trigger-start circuits where two lamps are started and operated in series, less extensive tests show less or no loss of life. This indicates that series-starting delays full arcing until cathode preheat is available.

Series ballasts for instant-start lamps. In lamps designed for instant-starting, none of the above complications apply. On this type, the only starting problem affecting lamp life is that of the series or sequence-start ballast. The ballast industry has developed these designs in a successful effort to improve the economics of lighting, and they provide lower losses, lighter weight, and lower cost. Lamp performance on this circuit has already been the subject of a paper,[9] and Fig. 11 summarizes the information reported there, plus new data obtained since. Life relative to that obtained on lead-lag circuits is shown in relation to the starting current, with the latter determined in accordance with industry procedures. Note that ballasts meeting the 100 ma minimum specification limit of the industry average about 85 per cent of lead-lag life. The wide spread shown in Fig. 11 for various test comparisons of the same ballast designs again illustrates the difficulty of furnishing any quick, yet reliable determination of how a new ballast circuit affects lamp life.

Life variables on rapid-start lamps. No serious troubles with life are anticipated or have been reported to date on this relatively new system. Much of the above background on life variables was taken into account in designing the rapid-start system to

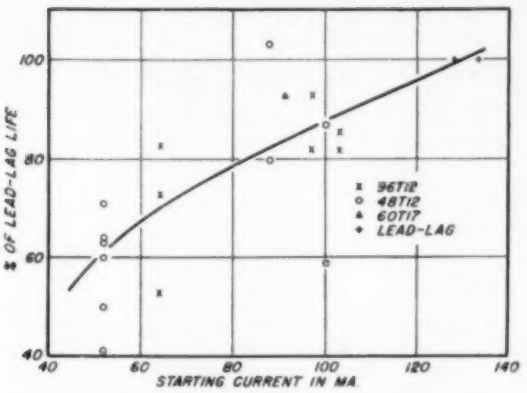

Figure 11. Effect of series-circuit starting-current on lamp life relative to life on lead-lag circuit. (Starting current is measured at 90 per cent of rated supply voltage through specified resistor.)

be free from them. This system depends on a relatively low open-circuit voltage to delay striking the main arc until the cathodes have heated.

Where higher open-circuit voltages are required to start lamps reliably at low ambient temperatures, some instant-starting is likely at normal ambients. Since the cathode is the triple-coil construction (Fig. 2, right), life reduction should not be serious. The use of series-circuits is preferable for longest rapid-start lamp life because, as mentioned above on trigger-start circuits, series-starting tends to delay instant-starting momentarily, and so allows time for full cathode heating.

Acknowledgments

The extensive field covered by this paper was made possible only by important contributions from a group of engineers too numerous to include as co-authors. Particular thanks are due W. J. Karash, D. D. Hinman, S. B. Clarke, L. F. Kramel, A. Brownell, W. C. Louden, R. L. Woodhouse and W. H. Lake of our Lamp Development Laboratory; E. M. Kooker, J. F. McClenahen, R. J. Smith and B. R. Buus of our Quality Control & Testing Department; and A. C. Barr of our Application Engineering Department.

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Light and Color Engineering in Post Offices

Discussion of paper by Tom C. Cargill, Jr. and Curtis E. Kautt

(Published October 1954 ILLUMINATING ENGINEERING)

T. F. COGHLAN*: I congratulate Mr. Cargill and Mr. Kautt on their very clear and complete explanation of the Post Office Department's seeing problems and the action they have taken to overcome and correct them. The Post Office does have problems peculiar to their normal operations that are not found in other businesses.

The trial installations referred to, especially the first one at Richmond, Virginia, have very effectively proven the value of improved lighting to the employer as well as to the employee. It is encouraging to see the new trend of thinking that has developed at the Post Office Department in the last several years. Starting under Mr. Leighton's vigor and enthusiasm this has had much to do with a very noticeable turning point in the lighting of Post Office workrooms.

I am personally gratified with the results of these installations because they have confirmed the correctness of lighting layouts prepared in my office at Public Buildings Service six or eight years ago for Post Office buildings that were to have been built after World War II. Unfortunately for the Post Office these plans never went ahead because funds for construction were not made available.

Fortunately for the cause of better lighting, however, the Post Office Department had funds available for experimental work which was used for trial installations and has brought the value of good lighting to the attention of the proper authorities, resulting in an appropriation earmarked for lighting improvements, which naturally include color conditioning as well.

I had the opportunity of working with Mr. Leighton on the Richmond project, as well as the other installations mentioned in the paper. Having a first-hand knowledge of the seeing conditions before and after, I can assure you that the improvement is even more impressive than the photographs show.

I am also happy to see that the General Service's standard lighting fixtures referred to in the paper have proven to be most satisfactory because the lighting of Post Office workrooms was the function foremost in our minds at

*Electrical Engineer, Public Buildings Service, Washington, D. C.

Public Buildings Service when designs of type 362 and 364 were being developed.

I would also like to point out that the standardization of lighting fixture design that has been practiced by Public Buildings Service is absolutely necessary to meet the flexibility required for future changes and addition of lighting units in existing rows of fixtures as referred to in the paper under "Category No. 2."

This scheme of standardization makes it possible to obtain additional fixtures that match and fit perfectly with the original installation at any time in the future when conversion of "Category No. 2" is desired. And, of utmost importance to the Government, is the fact that these additional fixtures can be obtained through honest open competitive bids that are based on clear and definite drawings and specifications that contain no trick requirements to insure getting the particular fixtures necessary to perfectly match and fit the existing fixtures among which they are to be installed. This competitive manner of procurement also applies to obtaining parts because of standardization. This is quite important to anyone responsible for operating and maintaining several thousand buildings.

J. A. MEACHAM*: We have long needed positive evidence that improvements in seeing and working conditions do actually increase worker output, and equally important, that the increase in productivity is great enough to justify the cost involved.

Mr. Cargill and Mr. Kautt have supplied us with this information. The experience at the Richmond, Virginia, Post Office appears to be directly applicable to any working area. The fact that the work being done remained the same during the test period and the fact that other influential factors remained constant makes the resulting figures especially significant.

We have, for example, an approximate cost of $1.36 per square foot for installation of new lighting, painting and ventilation. The unit production in the Richmond experiment showed a total increase of 8 per cent as a result of the renovation.

This is sound engineering data which will be useful to all of us in promoting the idea of better seeing and working conditions for industry. On the basis of the authors' analysis, the pro rated cost of the improvement for each employee was $23.15 per year — whereas the dollar value of an 8 per cent increase in production was $320.00 per year for each employee. Considering there were 226 full-time employees involved, the theoretical total saving per year was $45,000 and more than paid off the total cost of the improvement ($34,714.65) the first year of operation.

Mr. Cargill and Mr. Kautt are to be congratulated on this helpful contribution to the basic engineering of our profession. Those who, like myself, are interested in the field of color as a factor in better lighting will be especially pleased at the emphasis placed by the authors on the selection of proper reflective surfaces and developing good seeing and working conditions.

I might add that there has been a growing awareness among paint manufacturers of the fact that they have a vital interest in working hand in hand with the lighting engineer. I am sure that my fellow representatives of the paint industry would be glad to join me in expressing our appreciation to Messrs. Cargill and Kautt, as well as the Illuminating Engineering Society as a whole, for the cooperative manner in which it has accepted our interest and effort in the field of better lighting and better seeing.

J. M. KETCH*: While I.E.S. has reported numerous papers showing increases in store sales, plant production, egg production, growth of African violets, etc., as a result of better application of light, we have had very few on productivity in offices and similar areas. This is probably, in part, because of the non-repetitive nature of the tasks. Those tests that have been reported include the significant tests at the Bureau of Internal Revenue — 55 per cent increase in production of key punch operators, 10 to 50 footcandles, which pays for its installation cost every six months. A later test at the Department of Census with lesser illumination changes still shows significant increases in productivity.

Many of us are grateful to the authors for this report on Post Office lighting. The pro-rated cost per year, per benefited employee of $23.15 is *interesting;* the increased production of 8 per cent over the base 1951 rate is *amazing;* but when we find that this increase, based on an average $4000 salary, will repay the cost of the improvements *each month,* this fact becomes very significant to both those who design lighting and those who buy it.

ROBERT A. MILLER**: I also wish to express appreciation of the comments of Messrs. Cargill and Kautt on the cooperation of the paint industry in selection of colors, proper reflective surfaces and good performance in the rehabilitation of the Richmond Post Office, and thereby to emphasize the discussion by Mr. James A. Meacham.

Also, and more particularly, I would like to forestall a deluge of unnecessary enquiries. In his presentation Mr. Cargill stated that the "observation galleries are glazed with one-way glass." I would like to emphasize that there *is* no such animal. The observation galleries are glazed with a very special more or less neutral color glass which will transmit not more than 10 per cent of the incident light and not less than one per cent of any wavelength of the visible light. This means that one can see through the glass from the darker side to the more highly illuminated side, but it makes no difference how the glass is set — it makes no difference which face of the glass is toward the light. Let me emphasize again that there is no such animal as a "one-way" glass.

*The Sherwin-Williams Co., Cleveland, Ohio.

*General Electric Co., Engineering Division, Nela Park, Cleveland, Ohio.

**Pittsburgh Plate Glass Co., Pittsburgh, Pa.

INSTALLATION AT DOEHLER JARVIS DIVISION OF NATIONAL LEAD COMPANY, POTTSGROVE, PENNA.

Industrial Lighting

LIGHTING OBJECTIVE: To provide general illumination for the cleaning and trimming of die castings.

GENERAL INFORMATION: The bay shown above is approximately 40 feet wide. The floor is concrete (25% RF) and ceiling is painted light green (60% RF). In this area die castings are trimmed both by hand and by automatic machines. The hand operation involves filing and scraping.

INSTALLATION: Westinghouse #2 SPC-75 (style 1569-368) luminaires each containing two 96-inch T-12 standard cool white fluorescent lamps operated at 420 ma are mounted 16 feet 6 inches above the floor in continuous rows on 10-foot centers. After 200 burning hours the illumination averaged 60 footcandles.

Lighting data submitted by Arthur V. Schafer, Philadelphia Electric Company as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Series XIX 11-54

A.I.A. File No. 31*f*

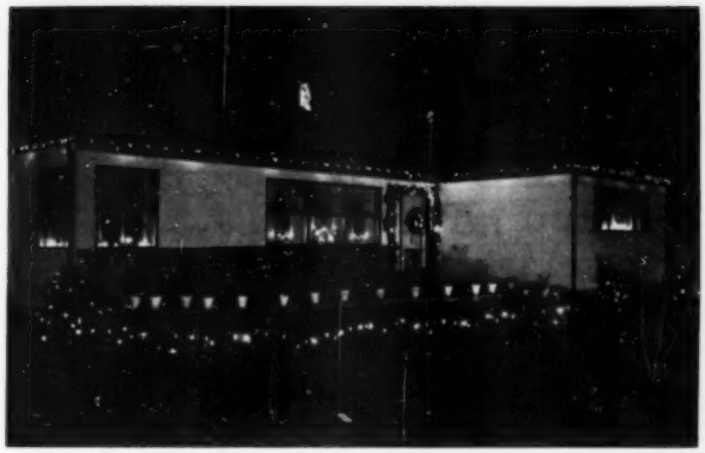
Merry Christmas

A Christmas Circle, a huge pine wreath, is dotted with silver foil ornaments and lighted by two PAR lamps on the lawn. The small tree on the door is hung with ornaments and icicles. A jovial oilcloth gamin beckons you to step through the circle to warmth and pleasure within.

A glistening frame of green, blue, red, gold and silver balls, attached to chicken-wire panels at the right and left sides, outlines a white door, with similar balls hung across the horizontal window above the door. The ribbon and pine branch wreath is spotlighted from above and the entire door area is floodlighted by a 150-watt PAR lamp located in front of the steps.

Strings of amber lights accentuate the lines of a peaked roof, and are entwined in laurel roping across the windows. Directed from behind at a "cathedral" window design, a 150-watt floodlamp illuminates the Madonna and Child and the "stained glass window" of colorful paper. Pine tree boughs are silhouetted in side panes of window. PAR lamp on the lawn lights the exterior of the house.

The horizontal lines of this ranch-type house are followed by the colorful lights in the bushes and along the edge of the roof. The entrance is hung with laurel, sparkling with lights, as is the wreath on the door itself. Lighted ornaments gleam from the windows, and a large lighted plastic Santa rests against the chimney. The whole house is floodlighted from three PAR lamps on the lawn, which pick out the row of ivy-filled flowerpots along the low wall.



Merry Christmas With Light

With elegant simplicity, Christmas loveliness is mounted against a delicate raspberry colored door. Huge gold balls are suspended at the bottom of the decoration and smaller ones of green, gold and silver are clustered in the center against a gold ribbon. A green felt bow and long green felt streamers mingle richly with the frosted silver pine and berry branches. The decoration is highlighted against the rose-pink door by a 75-watt spotlight in the ceiling outlet of the portico roof, and by a 150-watt PAR lamp on the top step. The vases flanking the entrance repeat the color of the door, with contrasting light green tops.

All photos and data courtesy of Miss Myrtle Fahsbender, Director of Residential Lighting, Westinghouse Electric Corp., Bloomfield, N. J.

Control of Electrical Lighting With Dimmers

By WILLIAM P. CARPENTER

A general discussion of dimmers for the control of light, their characteristics, comparison of advantages and disadvantages of various types, and suggested application. One of a series of articles outlining fundamental information on lighting application.

CONTROL of light today, as in the past, is man's attempt to parallel nature. In the commercial usage of light, however, whether in stores, homes, the theatre or elsewhere, some varying control is frequently an important part of the particular effect desired from the lighting design. Many devices exist for the control of light, controlling both the total amount of light and the color of light. However, when colors are to remain approximately constant, a convenient means of controlling the total light output is the use of a dimmer.

A dimmer, as defined in this discussion, will refer to a device inserted in an electrical circuit to control the electric power to the light source. The types of dimmers which are generally used are classified as:

Resistance — metallic wire
Reactor — saturable core — movable core
Induction voltage regulator
Tube type
Autotransformer — continuously adjustable voltage

Resistance Dimmer

In the early days of electric lighting, dimming effects were achieved by using resistance drop characteristics of series and parallel lamp connections, and later by switching the multiple filament lamps in various series and parallel combinations. A number of rheostatic type sockets, satisfactory in small electrical sizes, were also developed.

Historically, the water rheostat was employed in commercial lighting control. The attendant difficulties with water rheostats can be readily appreciated when one considers the difficulty of confining water to the rheostat, the production of gases due to electrolysis of water and the annoyance of exploding these gases if the rheostat is used on direct current. In view of other circuit elements which are much more satisfactory than the water rheostat, this type has been dropped in this discussion, and later types of electrical dimmers only are considered.

Fig. 1 shows the advantages and disadvantages of the various types of dimmers and a schematic diagram of each. Note that in this comparison of types, the advantage of the resistance type dimmer over all others listed is that it will operate on d-c as well as a-c. However, it is a loss type of device, which means that it is expensive to operate and produces considerable heat. Is is also load sensitive (has high regulation) in that the output voltage of the circuit varies as the magnitude of the load is changed. Because of high regulation it is necessary for it to be tailored to the particular size load; that is, if the dimmer is to dim properly 1000 watts and the load is reduced to another value of wattage, let us say 300, the intensity of the lamp under control changes considerably for the same dimmer setting.

Reactor Dimmer

The reactor type dimmer will operate on a-c only. It is not a loss type of device, but produces a poor power factor in the circuit because it is a reactive element. A series reactor is semi-load sensitive, depending upon the design. By semi-load sensitive, it is meant that regulation will be experienced much the same as in the resistance dimmer until the reactor has sufficient voltage across it to become saturated. When it is saturated, it absorbs essentially a constant voltage so that the remaining voltage which appears across the load is approximately constant. Prior to saturation it has a voltage drop proportional to load current.

The saturable core reactor's impedance is controlled by the degree of saturation in the core. This is done by a d-c winding through which a current is passed of such a value to produce the desired saturation.

The reactor has maximum impedance (maximum dimming effect) when there is zero d-c current through the d-c coils, and minimum impedance

AUTHOR: Chief Engineer, The Superior Electric Company, Bristol, Connecticut.

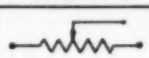
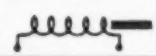
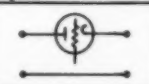
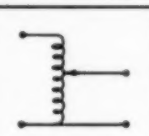
TYPE	SCHEMATIC	ADVANTAGES	DISADVANTAGES
RESISTANCE		LOW COST LIGHT WEIGHT A-C OR D-C OPERATION	LOAD SENSITIVITY HIGH LOSS EXPENSIVE TO OPERATE MUCH HEATING
REACTOR MOVABLE CORE TAPPED		LOW LOSS	A-C OPERATION ONLY LOW POWER FACTOR NOISY SEMI-LOAD SENSITIVE INCONVENIENT TO OPERATE
SATURABLE CORE REACTOR D-C CONTROLLED		LOW LOSS GREAT FLEXIBILITY IN REMOTE CONTROL VERSATILITY IN MASTERING FOR SPECIAL EFFECTS	A-C OPERATION ONLY LONG TIME CONSTANT EXPENSIVE SEMI-COMPLICATED CIRCUIT SEMI-LOAD SENSITIVE
SERIES TUBES		GREAT FLEXIBILITY IN REMOTE CONTROL VERSATILITY IN MASTERING FOR SPECIAL EFFECTS NEGLIGIBLE TIME CONSTANT	A-C OPERATION ONLY EXPENSIVE COMPLICATED CIRCUITRY APPRECIABLE WARM-UP TIME
AUTOTRANSFORMER CONTINUOUSLY ADJUSTABLE		LOW LOSS MODERATE COST INSENSITIVE TO LOAD (GOOD REGULATION) AVAILABLE IN A WIDE VARIETY OF SIZES AND CONFIGURATIONS MOTOR OPERATED TYPES PROVIDE WIDE FLEXIBILITY IN CONTROL AVAILABLE FOR LARGE AMOUNTS OF POWER	A-C OPERATION ONLY NOT AS FAST AS SERIES TUBES

Figure 1. A comparison of several types of dimmers.

(minimum dimming effect) when the d-c winding is carrying maximum current. Between these two limits a smoothly adjustable impedance value is obtained by adjusting the d-c current. It can be seen immediately that the saturable core reactor lends itself to remote control.

The degree of flexibility in this remote control is limited only by the ingenuity of the circuit designer and the complexity of the circuit which he is willing to employ. The time constant of this circuit is largely dependent upon the L/R ratio of the d-c coil and associated circuit.

Induction Voltage Regulator Dimmer

The induction voltage regulator is sometimes used as a lighting control, but its usage has not been common. However, it is adaptable for controlling large amounts of power, but a relatively long time is required for voltage change. The device is efficient, but can be used only on a-c.

Tube Dimmer

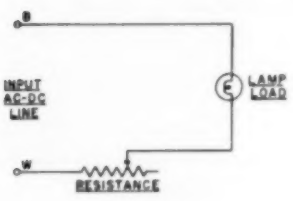
When a tube type dimmer is used, in general the grid controlled gas tube — the thyratron — is employed, and dimming is achieved by controlling the firing angle of the tube. This type of dimmer permits exceedingly flexible circuitry. Tube dimming equipment is apt to be rather complicated because of the attendant apparatus required such as filament transformers and phase shifters. Also a time delay mechanism should be used to permit warming up of the filament before plate voltage is applied. Equipment of this sort is relatively expensive, but lends itself exceedingly well to elaborate control schemes. It has a negligible time constant.

It is to be noted that the term "time constant" is not to be confused with the initial warm-up time which is required on tube equipment.

Figs. 2 and 3 show schematically the circuits of the rheostat, sliding core reactor, d-c controlled saturable core reactor, induction voltage regulator, and grid controlled tubes used as dimmers.

Continuously Adjustable Autotransformer Dimmer

The continuously adjustable autotransformer is ideally suited to general usage. This is shown diagramatically in Fig. 4. It will operate only on a-c, but with negligible losses and heating, is available in a large variety of electrical sizes and mechanical configurations, and is not load sensitive. The autotransformer consists of a magnetic core having a copper winding. Each turn of the copper



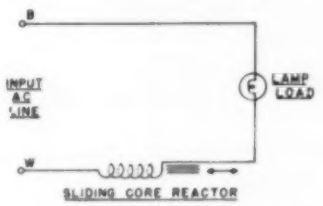


Figure 2. Schematic diagrams for (far left) resistance dimmer, and (left) sliding core reactor dimmer.

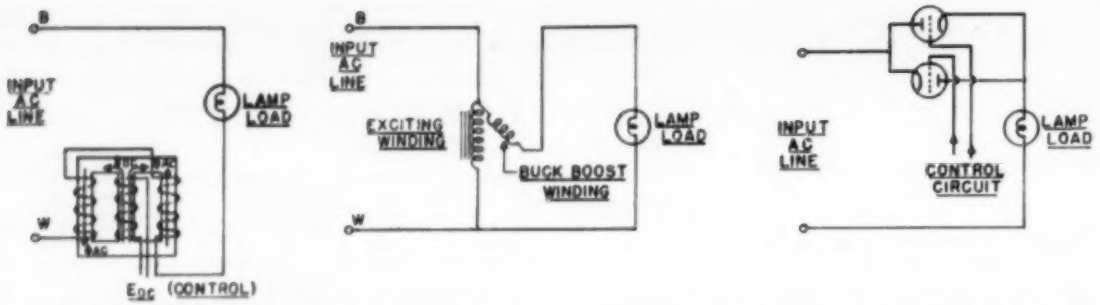


Figure 3. Schematic diagrams for (left) saturable core reactor dimmer, (center) induction voltage regulator used as a dimmer, and (right) thyratron tubes used as a dimmer.

winding is bared so that the sliding contact may be rotated across any of the turns. This is a commutating type of contact so that the circuit is not interrupted.

The output voltage is dependent upon the number of turns encompassed between the sliding contact and one end of the winding. The autotransformer has negligible load regulation because it is a tightly coupled transformer. The continuously adjustable voltage transformer is exceedingly versatile and available in a wide variety of configurations. For this reason it is the type most generally employed as a dimmer. The continuously adjustable autotransformer may be operated from a knob which is rotated by hand. This is shown in Fig 5. This dimmer is particularly useful in single dimmer installations or as an auxiliary to an existing installation.

Where it is required to have a dimmer arranged for more active operation, the continuously adjustable autotransformer dimmer is fitted with a conventional theater switchboard type of operating lever. This is shown in Fig. 6. Fig. 7 shows a group of autotransformer dimmers arranged for operation from lever handles mounted in an angle iron skeleton frame of a theater switchboard.

Packaged dimmers are available having transformer elements, lever operators; mechanical mastering, pilot lights, terminals and output connections. A typical packaged switchboard of this type is shown in Fig. 8. This unit contains four 2000-watt circuits.

A motor driven adjustable voltage autotransformer dimmer is shown in Fig. 9. The control of this motor is exceedingly simple, the motor being a three-lead reversible motor so that the control switch need be only a single pole, double throw type.

A servo type of remote control for the motor driven dimmer is available. Fig. 10 shows a console board for controlling positioner type motor driven dimmers from miniature control levers mounted on the console. The power controls, adjustable autotransformers, are remotely located on a switchboard. This positioner type of control employs a motor and a relay which perform the switching of the motor.

In the positioner type circuit, the continuously adjustable autotransformer has a potentiometer mechanically coupled to it. The control consists of a potentiometer which is bridge connected to the potentiometer on the autotransformer. The outputs of these two potentiometers are fed to a null relay which will be de-energized when the potentiometers are in electrical balance — the same mechanical positions. When this relay is energized due to displacement between the remote control and the autotransformer, the driving motor circuit will be closed and the motor operated until balance is restored.

This type of control provides the most flexible arrangement for use with the autotransformer type of dimmer. A miniature switchboard can be built

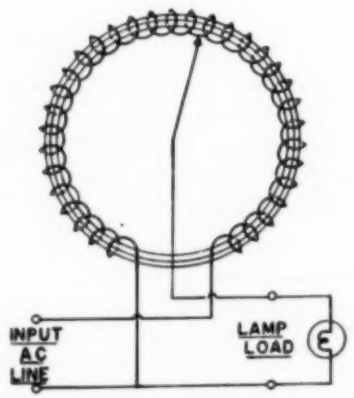


Figure 4. Schematic diagram for adjustable voltage autotransformer dimmer.

which will accommodate a large number of circuits and the switching of the circuits such as mastering, presets and the like can be easily accomplished to give the effects the lighting director wishes.

The dimmer shown in Fig. 11 has been designed for use in the home, or other lighting control applications where a simple wall switch has performed the control functions heretofore. This wall box dimmer is rated 360 watts and is of such dimensions that it will fit within a 2-inch by 4-inch studded wall. It has protective features of a fuse and circuit breaker, and has been approved by the Underwriters' Laboratories, Inc. It must be remembered that since it is a transformer, two feed wires and two load wires must be brought to it.

Only a low loss device could be used for this

Figure 5. 2000-watt autotransformer dimmer.

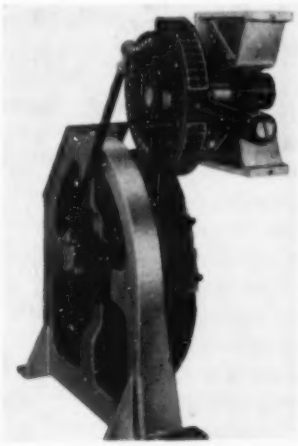


Figure 6. 6000-watt autotransformer dimmer for incorporation in switchboards.

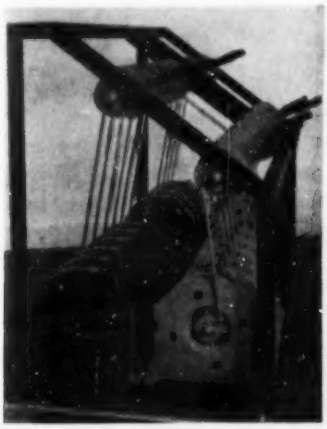


Figure 7. Skeleton switchboard employing 6000-watt interlocking autotransformer dimmers.

Figure 8. Package dimmer employing four 2000-watt autotransformer dimmers.

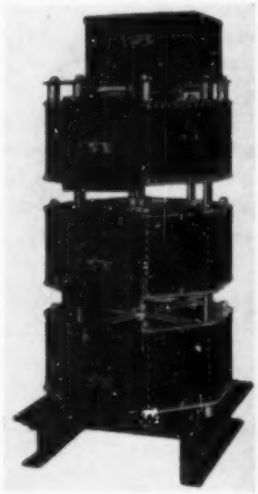


Figure 9. (above) Motor operated 3-section 5000-watt per section autotransformer.

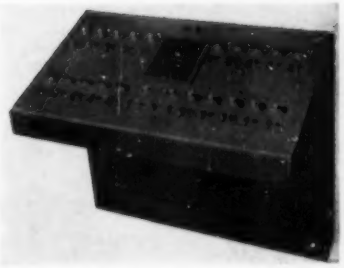


Figure 10. (above) Console for positioner dimmer.

Figure 11. (left) Wall box dimmer.

"within the wall mounting." The rheostat is obviously unsuited for such application because of the large amount of heat which it produces. Since the dimmer cannot be satisfactorily ventilated when mounted within the wall, a rheostat type dimmer would create dangerous temperatures. For that reason a device having very high efficiency must be used. The continuously adjustable autotransformer was selected because of its very high efficiency and mechanical adaptability.

Fluorescent Control

Dimmers can also be used to control fluorescent lighting of either the hot cathode or the cold cathode type if proper circuitry is employed. To dim hot cathode fluorescent lamps, the 40-watt rapid start type lamp is commonly used. A special ballast is employed which contains windings for continuously heating the filaments at all times during operation. A thyratron tube arrangement is employed to carry the arc current. This thyratron circuit has firing angle control so that the average value of current through the fluorescent tube is dependent upon the firing angle of the thyratrons. Thus dimming is achieved in a very satisfactory manner.

Cold cathode fluorescent lamps can be dimmed when they are series connected and operated from a high voltage sign lighting type transformer of the nonvoltage stabilizing type. The light output can be changed by adjustment of the primary voltage to this transformer.*

Dimmer Application

In the home, dimmers find application in practically every room. In the living room a dimmer might be used to set the mood, for relaxation, games or television viewing. Employed in the dining room, the dimmer is adjusted to the requirement. For example, when the table is being set, the lights are full on; during the meal, the lights are reduced by operation of the dimmer. In a child's room a dimmer finds particular application in that the lights can be brought up from blackout to a level required to observe the children, and be brought down again to blackout without any optical percussion. Gradually changing illumination produces essentially zero disturbance of a sleeper.

The application of dimmers to auditorium lighting is well known and has been observed by everyone. Their use here is to produce atmospheres of gaiety, suspense, reverence, etc. They are used in movie houses, legitimate stage houses, night clubs, lodges and churches.

Commercial lighting such as store lighting, window displays and counter displays often uses dimmers for effective variation of the lighting design. Frequently the dimmers are automatically changed in setting from a program controller. This program control of dimmers has been employed in store window lighting and outside displays such as fountains and general novelty applications.

Dimmers are finding increased use in hospitals. In the past, patients' rooms have often been equipped with two lighting circuits — one with on-off control for general illumination and the other with on-off control for night light service. Better control can be achieved by using a single lighting circuit and dimmer, and at a lower cost than the two-circuit system.

This presentation covers the subject of dimmers in a general descriptive way. An effort has been made to cover the features of dimmers which are of concern to the user of lighting control equipment. Technical information on any particular type of dimmer may be obtained from the manufacturers of each.

*ILLUMINATING ENGINEERING, June 1951, Vol. XLVI, No. 6, "Application Data for Proper Dimming of Cold Cathode Fluorescent Tubing," by William P. Carpenter.

General Secretary's Report in December I.E.

The annual report of the General Secretary to the membership of I.E.S. — covering the growth of the Society during the past fiscal year, its administration and financial status, and the reports from the General, Standing and Technical Committees — will be a feature of the December issue of ILLUMINATING ENGINEERING.

Some Problems Involved in the Design of Fluorescent Lamps

By ERWIN F. LOWRY
W. CALVIN GUNGLE
CHARLES W. JEROME

THE performance of a fluorescent lamp is determined by a number of factors some of which are interdependent and some which are mutually opposed to each other. The geometry of the lamp envelope, lamp loading in watts per unit area, the kind and pressure of the inert gas with which it is filled, and the chemical stability of the phosphor coating, as well as the design of the electrodes, are all lamp parameters which have an important bearing on lamp performance. The electrical characteristics of the auxiliary equipment and the ambient temperature in which the lamp is to be operated are factors external to the lamp itself which must receive due consideration. Architectural and esthetic considerations are also important and must be given proper emphasis when they affect the primary purpose of lamp design, which is to furnish ample light for comfortable effective seeing at the least possible cost.

In the sixteen years since the fluorescent lamp joined the ranks of important light sources, a formidable literature has been assembled covering many, if not all, the points referred to. However, there has been nothing static about the situation during these years. Instant starting used to be considered extremely destructive to the cathode; today instant start lamps have lives quite as long as those operated by switch type starting. Frequent starting or flashing of hot cathode lamps or operating them at variable loadings was considered well nigh impossible; now we have perfectly satisfactory dimming circuits and flashing signs with hot cathode lamps which are perfectly feasible — thanks to separate heating of the cathodes.

In view of these and many other innovations and improvements, it seems appropriate to re-evaluate some of the factors affecting the performance of fluorescent lamps to see where we stand regarding possible changes in lamp design in the continuing search for ways and means of furnishing more light at less cost.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 13-17, 1954, Atlantic City, N. J. AUTHORS: Sylvania Electric Products, Inc., Salem, Mass.

The Energy Relations

Since the fluorescent lamp is a gas discharge device, the energy it absorbs may be divided into two portions:

1. The energy absorbed at the electrodes which does not contribute appreciably to the light emitted and therefore is nearly a total loss. It is equal to about 19 I watts where I is the lamp current in amperes.[1]

2. The energy consumed in the positive column or plasma, part of which is utilized in the generation of useful ultraviolet energy and part of which is lost in elastic scattering or in recombination at the walls. It should also be pointed out that not all the ultraviolet generated reaches the walls and becomes effective in exciting the phosphor coating. This is the phenomenon known as "imprisonment of radiation." At least some of the ultraviolet energy generated near the center of the discharge column will strike and excite mercury atoms. These excited atoms may or may not re-radiate this energy as ultraviolet. In any event this process results in a corresponding decrease in the amount of fluorescent visible light emitted by the lamp. As might be expected, this loss increases with increasing diameter of the bulb and with increasing mercury pressures.

In general, the energy balance in a fluorescent lamp is given by a very simple mathematical expression:

$$L = m\ (W - 19I)$$

Where

L = total light output in lumens

m = a number representing phosphor efficiency and the efficiency of conversion of positive column watts into ultraviolet output reaching the phosphor. This number thus will vary with the color and quality of the phosphor, the lamp diameter and gas filling. For T12 lamps filled with 3 mm of argon and using present day white halophosphate phosphors and operated at 400 ± 25 ma., this figure is 80.

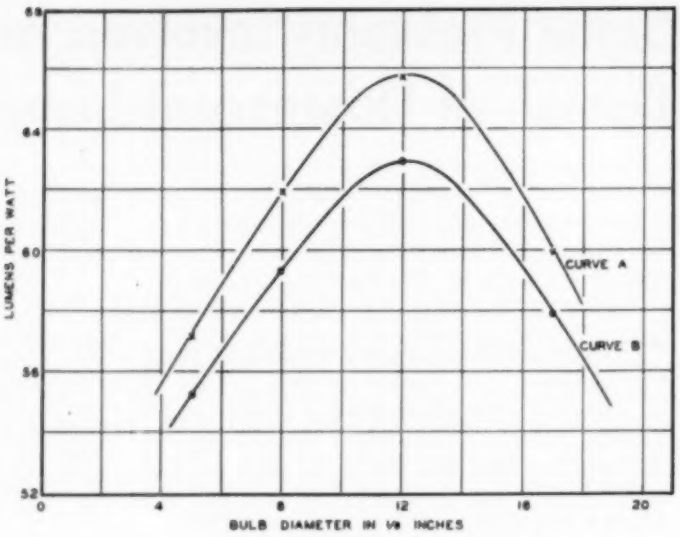


Figure 1. Effect of Bulb Diameter on Efficiency

Curve A — At maximum efficiency

Curve B — At rated loading

W = lamp watts and is proportional to arc length + a constant

$19I$ = electrode loss.

Another way of expressing this relation is

$$\text{Efficiency } (LPW) = m\left(1 - \frac{19I}{W}\right)$$

Lamp Dimensions

Since the lamp wattage at a given current is a function of lamp length it is obvious from the above equation that the longer the lamp the higher will be its efficiency. The maximum efficiency ($m\ LPW$) will be reached when the lamp is of infinite length. Practical considerations, of course, limit the length of lamp which can be made and handled satisfactorily. This length seems to be about 96 inches, at which length the lamp will have an efficiency about 90 per cent of the maximum to be expected.

Not only is the length of the lamp important from an efficiency viewpoint but also its diameter. It turns out that there is an optimum diameter for an efficient lamp. There are at least two important reasons for this situation. In lamps of small diameter an excessive amount of energy is lost by recombinations of electrons with ions at the walls of the discharge tube. As the tube diameter is increased, this loss becomes progressively smaller but losses due to "imprisonment of radiation" become correspondingly greater. The result of these two opposing factors gives a curve of efficiency as affected by bulb diameter, as shown in curve *A* of Fig. 1. This curve was obtained by measuring the maximum efficiencies after 100 hours operation of 5 lamps each of four different diameters but all having nearly the same lamp voltages and then plotting the maximum efficiencies so obtained against the bulb diameter. The lamps used for this investigation were:

Lamp	Diameter
13T5	.625 inch
30T8	1.00 inch
40T12	1.50 inches
40T17	2.125 inches

All lamps were filled to approximately 3 mm pressure and were coated with Cool White Halophosphate phosphor. All measurements were made in an integrating sphere at 80°F ambient temperature. Curve *A* shows this relation at the loading for maximum efficiency. Curve *B* indicates a similar relation between *LPW* and bulb diameter at the rated loading for each lamp. Both curves show a definite maximum in efficiency for lamps with a bulb diameter of about 1.5 inches. The difference in efficiency between curves *A* and *B* arises since all lamps are loaded beyond the point of maximum efficiency at their rated currents and 80°F ambient temperatures. The relation of loading to efficiency will be considered in some detail in a later paragraph.

Kind and Pressure of Inert Gas Filling

Easily ionized mercury atoms are important as the secondary source of electrons and ions in the discharge of a fluorescent lamp and excited mercury atoms are responsible for the ultraviolet radiation necessary to cause fluorescence. However, the presence of an inert gas such as argon at a low pressure is equally necessary for several reasons. For example:

1. The presence of an inert gas is necessary to

permit easy starting, particularly at low ambient temperatures when the mercury vapor pressure is extremely low.

2. During normal operation, the inert gas atoms serve to protect the cathode from the destructive effects of mercury ion bombardment. The presence of the inert gas also serves as a deterrent to barium vaporization and the resultant formation of anode spot discoloration. Although the inert gas filling plays a very small part in lamp conductivity and almost none at all in the process of fluorescence, it does absorb considerable amounts of energy. This absorption is the result of elastic collisions between electrons and gas atoms. The amount of energy consumed by this process varies with the pressure and the atomic weight of the gas as well as the collision cross-section of the gas in question.

C. Kenty, Easley and Barnes[2] have shown that in a 40T12 lamp, filled with argon at 3.5 mm pressure, about 9 watts or 22 per cent of the total energy consumed by the lamp is absorbed by elastic collisions between the electrons and argon atoms. A variation in argon pressure might be expected to influence the energy consumed by these collisions and therefore to affect lamp efficiency. Fig. 2 shows that this is exactly what does happen. This figure shows that, over the range of pressures normally considered usable, an increase of about 3 *LPW* per mm decrease in pressure is encountered. This agrees quite well with experience as determined from many measurements comparing the efficiency of standard 40T12 lamps filled to 3-mm pressure with 40T12 low temperature lamps filled to 1.8 mm pressure. This information is indicated by the circled dots in the figure.

In the past these low pressure lamps have had a much shorter life than lamps filled to 3-mm pressure and their lumen maintenance was not as good. This situation has now been largely rectified. Chemically stabilized phosphors and improved methods of processing them have resulted in a fluorescent coating which gives remarkably good lumen maintenance very little responsive to variations in gas pressure. Fig. 3 illustrates this situation. Here are plotted the lumen efficiencies for numbers of 40-watt lamps at various burning hours. Curve *A* is that for standard 40-watt lamps filled at 3 mm. Curve *B* illustrates similar data for "low temperature" lamps filled at 1.8 mm. It is obvious that the low pressure results in an improved lumen output not only initially but throughout lamp life.

Next comes the question of kind of gas used. It has been shown by Found[3] that elastic scattering losses are less with krypton than with argon and by Meister and Heine[4] that krypton-neon or krypton-argon mixtures are still more efficient. Dr. John Waymouth of our laboratories has calculated that in 40T12 lamps the watts loss by elastic scattering in argon, krypton, and xenon respectively at 3 mm pressure are:

Argon	9.3 watts
Krypton	6.0 watts
Xenon	6.7 watts

The losses per collision for electrons in these gases are in inverse ratio to their molecular weights (A_g) which are:

$$A = 40$$
$$Kr = 84$$
$$Xe = 130$$

However the probability of a collision (P_c) between an electron of about one electron volt energy and these gases at a given pressure are, according to Brode,[5] in the ratio of 300/400/700.

Therefore, although the losses per collision are inversely proportional to the molecular weight of

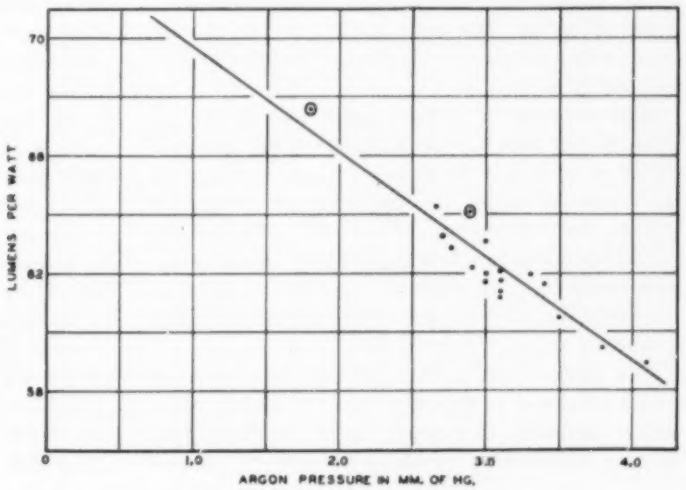


Figure 2. Effect of Fill Pressure on Efficiency of 40T12 Lamps

· — **Individual lamps**

⊙ — **1953 average of production lamps**

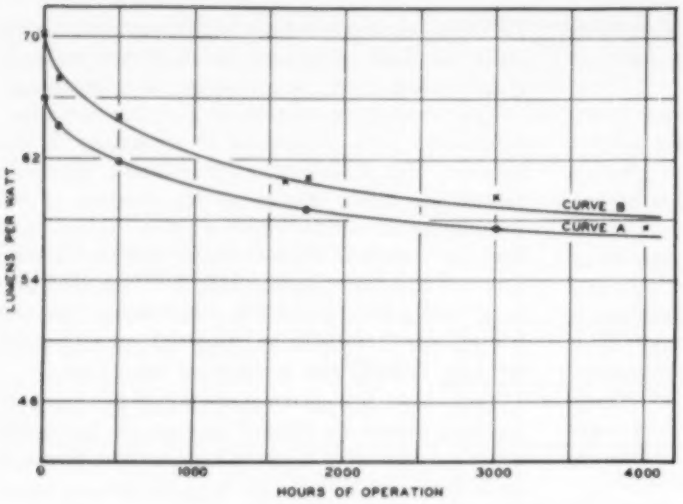


Figure 3. Lumen Maintenance of 40T12 lamps

Curve A — Production lamps at 3 mm argon

Curve B — Low temperature lamps at 1.8 mm argon

the gas atoms, the relative energy losses due to elastic collisions are proportional to P_c/A_g. The ratios for the three gases are:

$$A = 7.5$$
$$Kr = 4.8$$
$$Xe = 5.4$$

It turns out that scattering losses in krypton are less than in xenon even though krypton's atomic weight is much less. This is in agreement with the experimental results of Meister.[6]

This leads to the conclusion that krypton, or a mixture of krypton and argon as the fill gas will give an increase in efficiency over argon.

Both lower pressure and higher atomic weight of the fill gases have important effects on cathode performance. In general, lamp life is nearly proportional to gas pressure. On the other hand, krypton with its high mass gives more effective protection than argon. Lamps such as the 85-watt 60T17 lamp filled with 2 mm of krypton have quite as long a life as have 100-watt 60T17 lamps filled with 3 mm of argon. The same holds true for 90-watt lamps which are filled with 2 mm of a 50/50 argon-krypton mixture.

Improvements in cathode design and the use of zirconia additions to the cathode coating have resulted in a cathode which is extremely resistant to the erosive effects of ion bombardment, even with instant start operation. When such cathodes are operated on separate heating circuits, such as presently used for "rapid start" operation, they may be expected to furnish quite satisfactory operating lives even at low gas pressures.

Low pressures of a "heavy" gas have an additional advantage in that they have less cooling effect on the cathode. As a result, larger cathodes may be used which carry increased amounts of emissive material and which have larger emitting areas and, therefore, longer lives with the same consumption of heating energy.

In connection with the use of a different gas at another pressure than the normal argon at 3 mm (Hg) pressure, several resultant design factors must be considered.

1. What effect do these changes have on the electrical characteristics of the lamp and on its total light output?
2. What effects, if any, will they have on cathode performance?

We have already discussed the effect of argon pressure on efficiency and lumen maintenance. Found, in the paper already referred to,[3] has shown that the general effect of lowered gas pressure or gas of higher atomic mass is to reduce the voltage drop through the lamp.

The point to be made here is that this decreased voltage loss in the lamp takes place in the plasma of the discharge. Since the discharge is carried almost entirely by electrons and mercury ions, there is little, if any, effect on the work required to get the electrons into and out of the discharge. That is, the electrode losses are not appreciably influenced except for the power required to heat the cathode and hence this power becomes an increasingly large portion of the total energy consumed by the lamp as the lamp voltage is decreased.

For example: In the 60T17 bulb filled to 3 mm with argon, the lamp voltage is 73 volts. The same bulb filled to 2 mm with krypton and operated at the same current (1.42 amp) has a lamp voltage of 55 volts. The electrode loss in the first instance is 26 per cent, in the latter, 34.6 per cent. In longer slimmer lamps, this effect is proportionately smaller. In the 96T12 lamp for instance, the lamp voltage at 425 ma is 196 volts giving an electrode loss

of only 9.7 per cent. This lamp filled with only one mm of krypton has a lamp voltage at the same current of 170 volts with an electrode loss of about 11 per cent.

Ambient Temperature

Ambient conditions are of prime importance in determining the performance characteristics of a fluorescent lamp. Fig. 4 shows the effect of ambient temperature on the voltage required to start 72T12, 1.0 ampere, rapid start lamps on a series circuit. This is typical of the variation in starting voltage to be expected for any mercury discharge device with changes in ambient temperature. Of course, the open circuit voltage of the ballasting equipment must equal or exceed the lamp starting voltage at the lowest temperature at which the lamp is expected to be operated. In lighting installations where the ambient temperature is subject to rather wide variations, the problem for both the lamp and the ballast designer is to provide reliable starting at the lowest temperature to be encountered without getting instant starting at higher ambient temperatures. Outdoor lighting equipment is particularly subject to this wide variation of ambient temperature conditions.

Variations in ambient temperature also have a pronounced effect on the light output of a fluorescent lamp. The curve showing this variation has been presented in the literature many times. Most fluorescent lamps deliver their maximum light output at ambient temperatures in the neighborhood of 70-80°F. This points up an aspect of fixture design which must be given careful consideration, that is, that all fluorescent lamps, except those for low temperature operation, should be operated in well ventilated fixtures. This is a point which cannot be emphasized too strongly. The best efforts of the lamp designer to make a lamp of high light output and high efficiency can be completely nullified if the lamps are required to operate in poorly ventilated fixtures where the ambient temperature may, and often does, reach values in the neighborhood of 140°F. This situation is also very difficult for the ballast manufacturer who must build a heavier, more expensive ballast to prevent overheating if such high ambient temperatures are to be encountered.

Light Output

Another factor which is always in the mind of a lamp designer is the amount of light which can be most economically obtained. This is particularly important in fluorescent lamps where fixture costs are a large percentage of any installation. The more light delivered per lamp, the fewer fixtures required to obtain a given light level at the working surface. Again this is of great importance in modern installations which feature high lighting levels. However, in considering this aspect of high intensity, care must be taken not to make too great a sacrifice in luminous efficiency. This latter parameter must be maintained at a sufficiently high figure to insure that the user gets his money's worth for the amount of power consumed.

The 96T12 Lamp

Now let us examine the results to be obtained by making use of the principles discussed and conclusions reached in the preceding paragraphs.

They are:

1. The 96T12 bulb has the most efficient practical dimensions.
2. Rapid start operation gives a very efficient overall performance.
3. Lower pressures can be used to advantage.
4. Krypton or a mixture of argon and krypton gives the most efficient lamp.
5. A high intensity source is highly desirable for many applications if it can be obtained without serious loss of luminous efficiency.

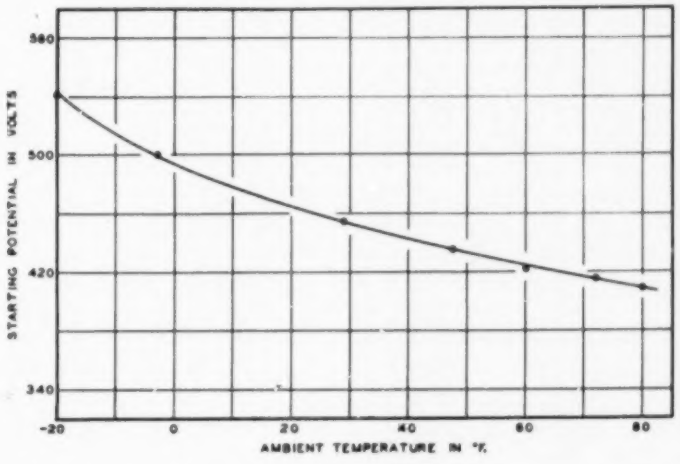


Figure 4. Effect of Temperature on Starting Voltage of 72T12, 1.0 ampere Rapid Start Lamps (2 in Series)

Figs. 5 and 6 present a set of curves showing the relative efficiencies of several 96T12 lamps filled with various pressures of inert gases and operated at different currents. In these measurements lamps were tested which had been aged for 100 hours. Triple coil cathodes designed to handle arc currents of 1.0 ampere were used. The lamps were operated on an instant start circuit rather than rapid start for ease of measurement. The ambient temperature was maintained at 26-27°C. In these measurements, the transformer voltage was kept constant and the lamp current varied by changing the impedance of a straight-line reactor. The lamps were operated at each current for sufficient time to reach equilibrium before electrical and light values were recorded.

A study of these figures reveals that appreciable increases in lumen efficiency are to be obtained at any current loading of these lamps if krypton or a 50:50 agron:krypton mixture is used for the gas filling over the efficiency realized with an argon fill at 3 mm (Hg) pressure. This efficiency is increased further by decreasing the fill pressure, as might be expected from Fig. 2. These curves (Figs. 5 and 6) show that for any gas filling, the lamps are loaded somewhat beyond the point of maximum efficiency when they are operated at 425 ma, and an ambient temperature of 26°C. They also show that 96T12 lamps filled to one mm pressure with 50:50 argon:krypton have at least as high an efficiency in *LPW* at 1.0 ampere operation as do present day argon filled lamps of the same dimensions when operated at 425 ma.

Cool white lamps have been made in 96 inch T12

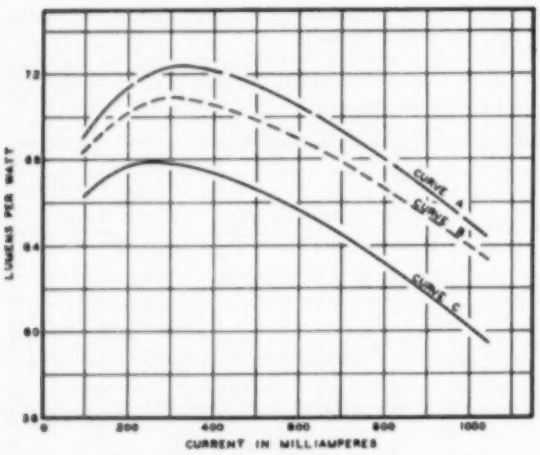


Figure 5. Efficiency vs Current — 96T12 Lamps at 3.0 mm Pressure

Curve A — Krypton fill gas
Curve B — 50 Argon : 50 Krypton fill gas
Curve C — Argon fill gas

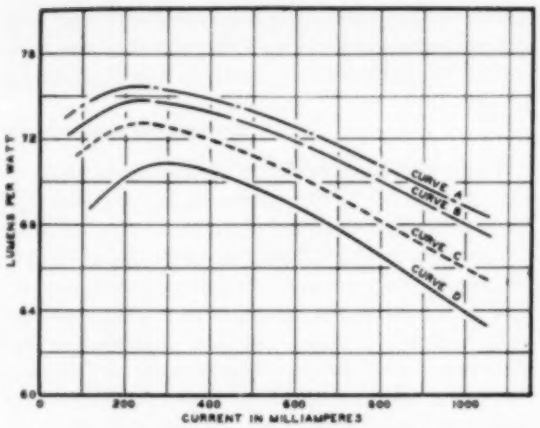


Figure 6. Efficiency vs Current — 96T12 Lamps with 50 Argon : 50 Krypton Fill

Curve A — 1.0 mm pressure
Curve B — 1.5 mm pressure
Curve C — 2.0 mm pressure
Curve D — 3.0 mm pressure

envelopes and filled to one mm (Hg) pressure with a 50:50 mixture of argon: krypton which have the following electrical and lumen characteristics after burning for 100 hours at 1 ampere on rapid start ballasts.

Lamp volts	134 volts
Lamp power	113 watts
Light output	7780 lumens
Luminous Efficiency	68.8 LPW

Curve A of Fig. 7 illustrates the variation in efficiency with ambient temperature of cool white 96T12 lamps filled with one mm of a 50:50 argon: krypton mixture and operated at 1.0 ampere on a series type of rapid start ballast. The data for 96T12 lamps operated at 425 ma taken from Holden's paper[7] are shown for comparison. The argon: krypton lamp at 1.0 ampere (113 watts) has a higher efficiency at all ambient temperatures below 80°F than does the regular argon lamp operated at 425 ma (74 watts) but its efficiency falls off more rapidly at temperatures higher than 80°F.

It is interesting to note that the 96T12 bulb has a surface area approximately 10 per cent greater than that of the 60-inch T17 bulb. It follows directly that the 96T12 lamp operated at 110 watts is loaded to the same watts per inch^2 of bulb area as the 60T17 lamp at 100 watts, or when operated at 100 watts, it is loaded the same as the 60T17, 90-watt lamp. In considering a 96T12 lamp loaded at 100 to 110 watts, therefore, we are not entering a new or unproven range of loading.

The consideration of a heavily loaded lamp places particular importance on the need for well venti-

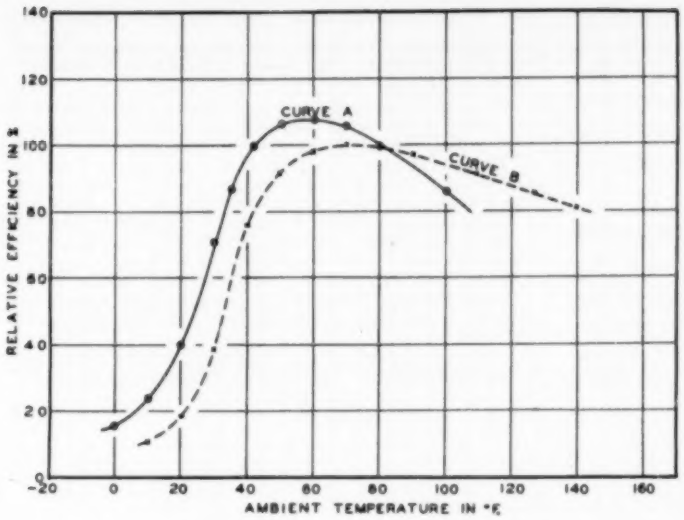


Figure 7. Effect of Temperature on Efficiency

Curve A — 50 Argon : 50 Krypton fill 1 mm pressure operated at 1.0 ampere

Curve B — Argon at 3 mm pressure operated at 425 milliamperes (From Holden[7])

lated fixtures. Fig. 7 shows that such lamps operate at maximum efficiency when the ambient temperature is about 60°F. As may be seen from an examination of the curves of Fig. 7, the 96T12 lamp at 425 ma may lose 20-25 per cent efficiency, and the more heavily loaded lamp, 40-50 per cent if ambient temperatures of 140°F are reached. As pointed out earlier, such temperatures may be found in poorly ventilated fixtures.

Lumen Maintenance

As has been pointed out many times, the initial light output or the initial efficiency of a lamp is not the only criterion upon which to judge a lamp's performance. It is at least equally important to know how well a lamp maintains its initial values. It has been shown by Lowry[8] that lamp loading in watts per inch^2 of phosphor area has an important effect on lumen maintenance. It turns out that the loss in lumen output at some specified time, such as 3000 hours, is nearly proportional to lamp loading. Of course, the better the maintenance the less important this factor becomes.

At the present time, T12 cool white lamps operated at 425 ma have a lumen maintenance of about 87 per cent at 3000 hours. This is a loss of 13 per cent. If then, the loading should be increased by 50 per cent, this loss might be expected to become about 20 per cent. That is, lamps so loaded should have a lumen maintenance of about 80 per cent after 3000 hours operation. This argument is based on lamps filled to 3 mm (Hg) pressure with argon. The question here is the effect of a low pressure of another gas or mixture of gases on this lamp parameter. Fig. 8 gives some indication of the results which may be expected. In this figure are shown

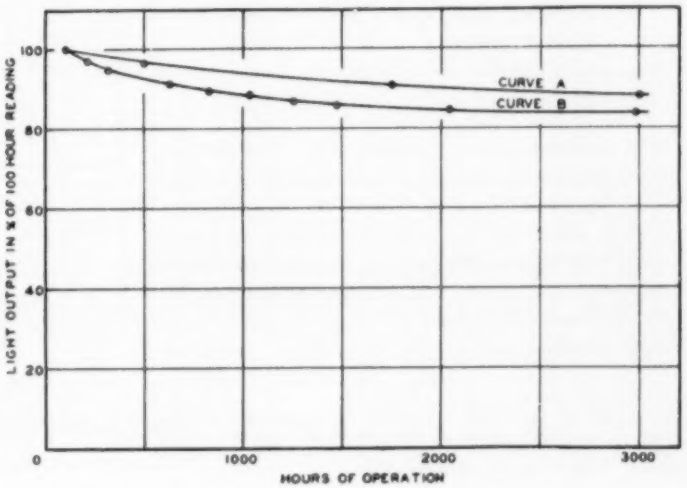


Figure 8. Lumen Maintenance of 96T12 Lamps

Curve A — Production lamps (3 mm Argon) operated at 425 ma.

Curve B — 1 mm 50 Argon : 50 Krypton operated at 1.0 ampere.

the lumen maintenance data for some 96T12 lamps filled to 1.0 mm of krypton and operated at 1.0 ampere, compared to similar maintenance data for standard 96T12 lamps operated at 425 ma. After 3000 hours burning, the per cent maintenance for the heavily loaded krypton lamps is at least as good as calculations would lead one to expect.

Acknowledgments

The authors wish to express their thanks to the various members of the Engineering Staff of the Lighting Division for their cooperation in gathering data for use in this paper, especially to Messrs. George Spears and C. Bernard Stiles who have been especially helpful in this respect.

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Classification of Luminaires by Distribution

Report of the I.E.S. Committee on Illumination Performance Recommendations*

FOREWORD

Illuminating engineers have long realized the need for a means of classifying direct and semi-direct luminaires by distribution of the direct component. After eight years of trial use by Society members,** the following system is offered as a simple and reasonable method.

Respectfully submitted,

I.E.S. COMMITTEE ON ILLUMINATION PERFORMANCE RECOMMENDATIONS

Benjamin S. Benson, Jr., *Chairman*

Robert D. Burnham	William H. Kahler
Kurt Franck	J. F. Parsons
S. K. Guth	Ray P. Teele
Leslie Innis	William Weibel

The classification of luminaires by distribution shall be expressed in terms of permissible spacing-to-mounting height ratios (above the work plane) to obtain illumination of suitable uniformity along a straight line running directly beneath two adjacent units. This ratio may be determined graphically as described below.

The classification by distribution in terms of ranges of permissible spacing-to-mounting height ratios shall be:

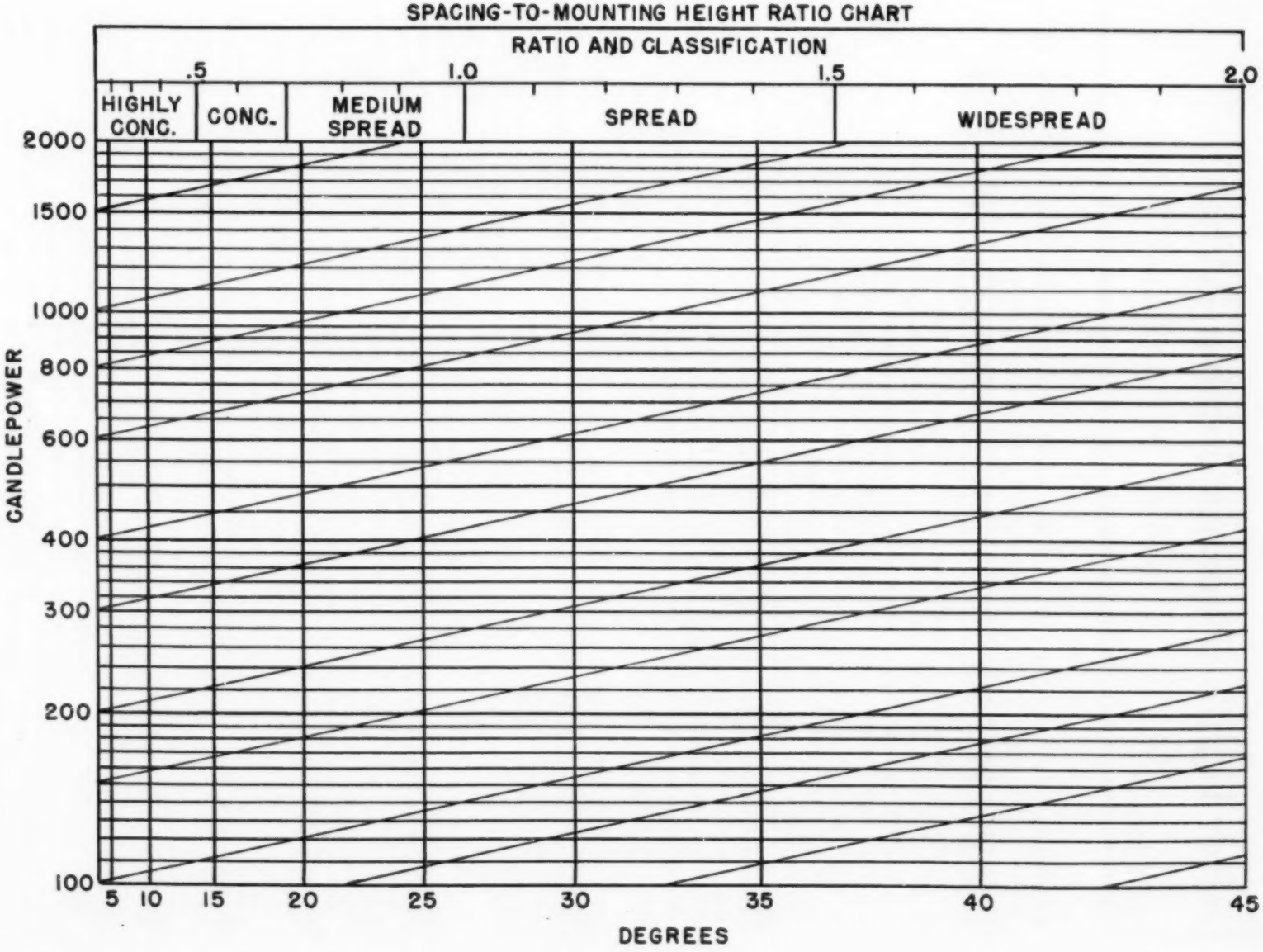
Spacing-to-Mounting Height Ratio (Above Work Plane)	Luminaire Classification
Up to 0.5	Highly Concentrating
0.5 to 0.7	Concentrating
0.7 to 1.0	Medium Spread
1.0 to 1.5	Spread
Over 1.5	Wide Spread

Directions for using the spacing-to-mounting height ratio chart:

1. Plot the photometric curve in rectangular coordinates on the chart.
2. Smooth out *any* pronounced irregularities in the curve.
3. On the left vertical edge of the chart take a point at one-half the candlepower at zero degrees and draw a line from this point parallel to the diagonal lines.
4. From the point at which this diagonal line crosses the photometric curve (as plotted on the chart), follow a vertical line up to the top of the chart and read the spacing-height ratio and distribution classification.

*Approved by the I.E.S. Council, June 1954.

**Essentially the same chart (in slightly different form) was included in an interim report of this Committee submitted to the Council in June 1946 and subsequently circulated to sustaining members of the Society for their comments.


SPACING-TO-MOUNTING HEIGHT RATIO CHART
RATIO AND CLASSIFICATION
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HIGHLY CONC.
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SPREAD
WIDESPREAD
CANDLEPOWER
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DEGREES

After Light's Diamond Jubilee—What?

An Editorial

CELEBRATIONS FOR LIGHT'S DIAMOND JUBILEE reached triumphant climax last month. All year, all over the country the public, the press, the power and lighting industries "in every hamlet, village and town" celebrated the development which seventy-five years ago was such a fantastic event. Much more fantastic, though, were the media used to celebrate the occasion — all developments of Edison's ideas. Celebrations for an invention which in 1879 brought gasps of disbelief and indignant protests even from scientific minds — were in 1954 observed through the media of television calmly viewed by 50 million people; 75,000-watt lamps observed with interest but little wonder; gorgeously lighted public buildings. Appreciation of the blessing of electric light was best felt by the millions of citizens who were victims of "Hurricane Hazel" which on October 15, 1954 plunged them back seventy-five years to darkened streets and flickering candles. Scientific progress in electricity and illumination has been so rapid that apparently nothing is fantastic any more. The wonders which the lighting and power industries have developed since Edison's first crude lamp are demonstrated most impressively by taking them all away.

What Now?

A REVIEW OF LIGHT'S HISTORY inevitably provokes introspection on the future. Twenty-five years to the Centennial Celebration could see undreamed-of further developments — probably only, however, if the same pooling of knowledge continues into the future as occurred in the past. Developments in lighting have not been jealously guarded for the commercial benefit of a few. Nor will they be during the next twenty-five years, judging from the current situation. The sharing of lighting knowledge is a growing trend — some of this education for sound commercial reasons, to be sure — much of it for selfless non-profit scientific purpose. At the time of Light's Golden Anniversary, twenty-five years ago, there were ten technical committees of the Illuminating Engineering Society. Today there are ninety-three. Hundreds of lighting experts from all over the country are brought together by this committee structure; the end result is dissemination of their combined knowledge to the public. If the past twenty-five years is noted for development in the art, perhaps the next twenty-five will see equal expansion of dissemination, lighting education and promotion, and wide-spread public acceptance of I.E.S. recommended lighting practice. Current surveys indicate there is room for expansion in this direction — much room. But if a tribute to progress to date may be based on a comparison with the status a given number of years ago, and the hopes for the future extrapolated at the same progressive rate — then wonderful wonderful things may be anticipated for 1979!

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Light's Diamond Jubilee Celebrated at

The 1954 National Technical Conference

It was not just coincidence that the 1954 National Technical Conference of I.E.S. was held in Atlantic City during the year of Light's Diamond Jubilee. Part of the Society's own observance of this historic occasion determined this locale — to tie in its own celebrations with those in Atlantic City. Actually it was a three-fold event — the I.E.S. Conference, which had special significance for the lighting world during this year; Jubilee celebrations which were especially prominent in Atlantic City; and the City's own celebration of its 100th anniversary. Added to this stimulating atmosphere was that of a seashore resort. Established long-time Society members who have attended twenty or more I.E.S. national conferences, agree almost to a man (and his wife) that Resort conventions leave the pleasantest memories.

Two separate aspects enter into a report of any I.E.S. conference. The stature of the technical program would tempt one reporter to record only the papers sessions, which in Atlantic City were very high-level indeed, the important committee meetings which were held from breakfast through late evening hours, and the stimulating discussions, either organized or extemporaneous. On the other hand, everyone had so much fun, after hours and between times, and it was all so smoothly handled by the Philadelphia Section hosts, this phase of the conference would definitely be of interest, now and for the record.

For future conference planners to look up years hence, as well as for the interest of current readers, the accompanying tabulation gives the pertinent statistics. In addition they might be interested to learn that the registraion of 854 delegates and guests represents attendance from 49 of the currently 68 Sections and Chapters. That New York Section had the largest representation with 118 present, but New Orleans Section had the "mostest from the farthest" winning the gavel and anvil attendance award again.

Report to Members

An important function of the conference is the annual report to the membership, by its national officers, on the "state of the union" you might say. Presentation of the year's achievements, future aims, financial picture, and other matters, review for the members their Society's affairs on a national scale.

This report to the members is traditionally a feature of the opening session of the Conference. President A. Homer Manwaring and General Secretary Marshall Waterman reported on the Society's progress as a national organization; incoming president Duncan M. Jones addressed the delegates on the aims of next year's administration. Text of Mr. Manwaring's address is published in full on page 413 of the September 1954 issue of Illuminating Engineering; that of Mr. Jones on page 415 of the same issue. The report of the General Secretary, complete with all financial, membership and committee statistics is scheduled for publication in the December 1954 number. Presiding at this session was Charles N. Laupp, Chairman of the National Technical Conference Committee.

Two special guest speakers were an additional feature of the opening session. A most gracious Address of Welcome was given by Mr. G. R. Swinton, City Engineer of Atlantic City, who also presented a "Key to the City" to President Manwaring. A welcome from the electrical industry was given by Mr. B. L. England, president of the Atlantic City Electric Company.

At the close of this session, President Manwaring introduced to the assemblage, two distinguished visitors from England, Dr. J. W. Strange, and Mr. A. G. Penny, Vice-President of the British I.E.S. Mr. Penny addressed the group, conveying a message from the President of the I.E.S. in his country, Dr. W. R. Stevens.

Dr. L. C. Kalff of Eindhoven, Holland accepted for his countryman, Dr. N. A. Halbertsma, the Certificate of Member Emeritus of our Society recently awarded to Dr. Halbertsma, now retired, in recognition of his many contributions to illuminating engineering both as a member of I.E.S. and during his professional career.

Conference Statistics

Time: September 13-17, 1954

Place: Chalfonte Haddon Hall Hotel
Atlantic City, N. J.

Attendance:

Registered delegates	614
Ladies	240
Total Registration	854

Banquet Attendance: 710

Gold Medal Award

A most impressive feature of the opening session September 13, was the presentation of the I.E.S. Gold Medal and Certificate to Dr. Erwin F. Lowry. This highest lighting honor was presented to Dr. Lowry by President Manwaring, together with a certificate bearing the citation:

Fellow of the Society, Scientist and Inventor, making original and significant contributions to the development of the fluorescent lamp, especially in cathode design for gas filled tubes.
Diligent and of utmost integrity in his research and in the report of his finding.
Doctor of Philosophy, Teacher, and Author of many technical reports of research data correlating the electrical and light characteristics of fluorescent lamps.

On the occasion of the National Technical Conference of the
Illuminating Engineering Society
Atlantic City September 13, 1954

The Medal has been awarded annually since 1944 except in 1951 and 1953, for meritorious achievement conspicuously furthering the profession, art or knowledge of illuminating engineering.

Photo Credits

The photos, on these pages, of people and events at the Atlantic City Conference are by courtesy of the following I.E.S. members:

Earle Hawkins, Atlantic City Electric Co.

Harry Grattan, Jr., Potomac Electric Co.

Robert C. Blatt, *Electrical World.*

On the Boardwalk: H. J. Martin, Chairman, Reception Committee with Executive Committee Chairman A. S. Turner and Katherine Goodall, Chairman, Ladies Reception.

"Travel Gavel" was won by the New Orleans Section with 8 members present at the Conference. Here it is accepted for the Section by 1954-1955 Chairman Arthur Levy.

President Manwaring and President-Elect Jones with Vice-President-Elect Marshall Waterman.

Charter Member and Past President George Stickney with S. G. Hibben, also a Past President, and Mrs. Hibben.

Ladies entertainment included a trip to the antiques display at the Smithville Inn and a visit to the Brighton Orchid Farm. At left, ladies are about to board the special bus for the expedition. At right, Atlantic City beach is enjoyed by Mrs. Harry Grattan, Mrs. George Clark, Mrs. H. V. Oerting, Mrs. M. L. Trostle with Master Trostle.

Seen at the Conference

A certificate of appreciation, signed by all the members of Council, is presented to President Manwaring by President-Elect Jones. Daughter Barbara Manwaring watches her Daddy with interest.

Committee Chairmen Maxwell Cole, Finance; and T. W. Lauer, Entertainment, compare notes.

Al Clarke, E. H. Church, A. P. Larson and Glenn Boyd get together between technical sessions.

On the Boardwalk: Presidents Manwaring and Jones join Willard Brown for an evening stroll.

At the hotel: George Stickney, Charter Member and Henry L. Logan chat between sessions.

On the beach: A. C. Barr comes in from a swim to talk with President-Elect D. M. Jones.

Guest speaker from Eindhoven, L. C. Kalff, accepts certificate of Member Emeritus for his compatriot, Dr. N. A. Halbertsma, who was recently elected to that grade in the Society.

In accepting the Society's Gold Medal, Dr. Lowry said that the scientist today can no longer be content to satisfy the demands of his scientific curiosity. "We as illuminating engineers," he said, "have no reason to be complacent. In no single phase of our activity has the ultimate been even nearly accomplished."

Dr. Lowry said that the scientist is becoming increasingly aware of his responsibility to take a more active part in the practical application of his discoveries. The lay public, he noted, is becoming more and more appreciative of the tremendous changes in our mode of living, in our relationships with other people and in the wonderful opportunities that derive from scientific investigation.

"Gains and improvements in the lighting field," he said, "have begun to match the flight of time. During the last 16 years, average luminous efficiencies have been increased by as much as 50 per cent. Lamp life has been trebled and end discoloration has been tremendously reduced. New and better methods of starting and operating these lamps have been devised." This he cited as an outstanding example of what can and does happen when many hands and minds are joined in a common cause.

Sanguine about the future of the lighting industry, Dr. Lowry warned, however, that there are still many problems regarding light and vision which are the common concerns of the Illuminating Engineering Society. "How well we succeed," he said, "determines the future of our leadership and, of more importance, in many ways determines the progress of our civilization."

Fellow Pins Presented

Another ceremony of interest at the Monday morning session, was the presentation by President Manwaring to ten newly-elected Fellows of I.E.S. of the distinctive white lapel pin signifying that highest grade of I.E.S. membership. Details of the ten elections to Fellow have already been published, on page 7A of the September 1954 issue. On hand for the presentation ceremony were:

C. E. Egeler, Cleveland Section
Myrtle Fahsbender, New York Section
Kurt Franck, Cleveland Section
K. S. Gibson, Capital Section
C. H. Rex, New England Section
F. D. Wyatt, Chicago Section

I.E.S. Gold Medal, highest honor of the Society, is presented to Dr. E. F. Lowry by President Manwaring. The Medal is accompanied by a Certificate of Award.

Pins will be mailed to:

D. M. Finch, Northern California Section
R. L. Oetting, Cleveland Section
R. A. Palmer, Tar Heel Section

Certificates of Fellow membership will be presented with appropriate ceremony at Section meetings, later in the year.

Environment Session

Continuing the practice of the past few years of featuring a special session of invited papers, an Environment Sym-

Newly elected Fellows receive pins from President Manwaring. In photo at left are: C. E. Egeler, Myrtle Fahsbender, Kurt Franck, K. S. Gibson, John Neidhart and Charles Rex. In the photo at right, Mr. Manwaring congratulates F. D. Wyatt. Not present to receive their pins were Dan Finch, R. L. Oetting and Roy Palmer.

Jubilee and Progress Report

At left, Thomas Edison and confreres work at the Menlo Park laboratory, and at right, Mary Taepke demonstrates the latest in garden lighting equipment during the residence lighting section of the Progress Report.

posium was held Monday afternoon, of very particular interest and value. This was a panel-type presentation with general debate on the three main environmental factors. Arranged by C. L. Crouch, I.E.S. Technical Director, this coordination of discussions on light, heat and sound attracted considerable attention of architects and other groups who came to Atlantic City in large numbers just for this session, as well as I.E.S. delegates.

The Acoustic Environment was represented by Robert B. Newman, Consulting Engineer with Bolt, Beranek and Newman Inc., Cambridge, Mass.

The Thermal Environment was under the direction of Nathaniel Glickman, Physiologist, of Miami, Florida.

The Luminous Environment was presented by Dr. L. C. Kalff who traveled from the Netherlands specially to participate in this important symposium. Dr. Kalff is associated with the N. V. Philips Glocilampenfabricken in Eindhoven, Holland.

A complete record of the technical program is included at the end of this report, for the record.

Progress Report

Light's Diamond Jubilee was the theme of this year's Progress Report. A very talented committee, under the chairmanship of Eugene W. Beggs (Westinghouse, Bloomfield) presented a pageant which commemorated progress since the first practical incandescent lamp 75 years ago, winding up with actual demonstrations of this year's progress in the art presented by members of the Committee. Clever skits featuring Edison and his lamp and other symbols of Light's Diamond Jubilee, included the following all-star cast:

Finale of Light's Diamond Jubilee celebration brought the whole cast on. Beautiful girl is, unfortunately, not an I.E.S. member, but ably supported Progress Committee Chairman Eugene Beggs by adding glamor to the more serious technical aspects of lighting progress.

Part I—Light's Diamond Jubilee

Tableau: The Clay Oil Lamp—Miss Jan Reynolds, New York Section, as a Vestal Virgin, Keeper of the Sacred Fire.

Tableau: The Candle — Priscilla and John Alden, New England Section.

Tableau: The Kerosene Oil Lamp — Mr. and Mrs. Arthur Jaeger, Western New York Section as the Farmer and his Wife.

Tableau: The Welsbach Mantel — Mr. Gensberger, New Orleans Section, as the Old Lamplighter.

Tableau: Edison at Menlo Park — Cleveland Section, Five-Man Crew. First Voice—Mr. A. Barr; Edison's Voice—Mr. A. Jaeger.

Tableau: Miss I.E.S. at Atlantic City — The Committee and Miss I.E.S., Charles Amick, Eugene Beggs, A. C. Barr, H. F. Carroll, O. P. Cleaver, J. E. Gornet, B. Greene, M. E. Keck, A. S. Jaeger, H. A. Kliegl, J. H. McCulloch, J. A. Moacham, H. F. Kingsbury, T. C. Sargent, R. P. Teele, Mary Taepke, H. A. Williams.

Tableau Production by Art Jaeger.
Lighting by Herbert Kliegl.
Projection by Hugh McCulloch.
Sound Effects and Music by Al Williams.
Stage Manager, H. F. Carroll.
Committee Chairman, Gene Beggs.

Part II—Lighting Progress, 1953-1954

Sections on Statistical Data, Measurements, Education, Military, Foreign, Ultraviolet, Infrared, Photographic and Miscellaneous, presented by Eugene Beggs, Chairman.

Lamps, presented by Charles Amick.

Equipment, presented by J. E. Gornet.

Home Lighting, presented by Miss Mary Taepke.

Applications, presented by M. E. Keck.

The Progress Report is traditionally a highlight of an I.E.S. Conference. Old hands at these affairs know enough to

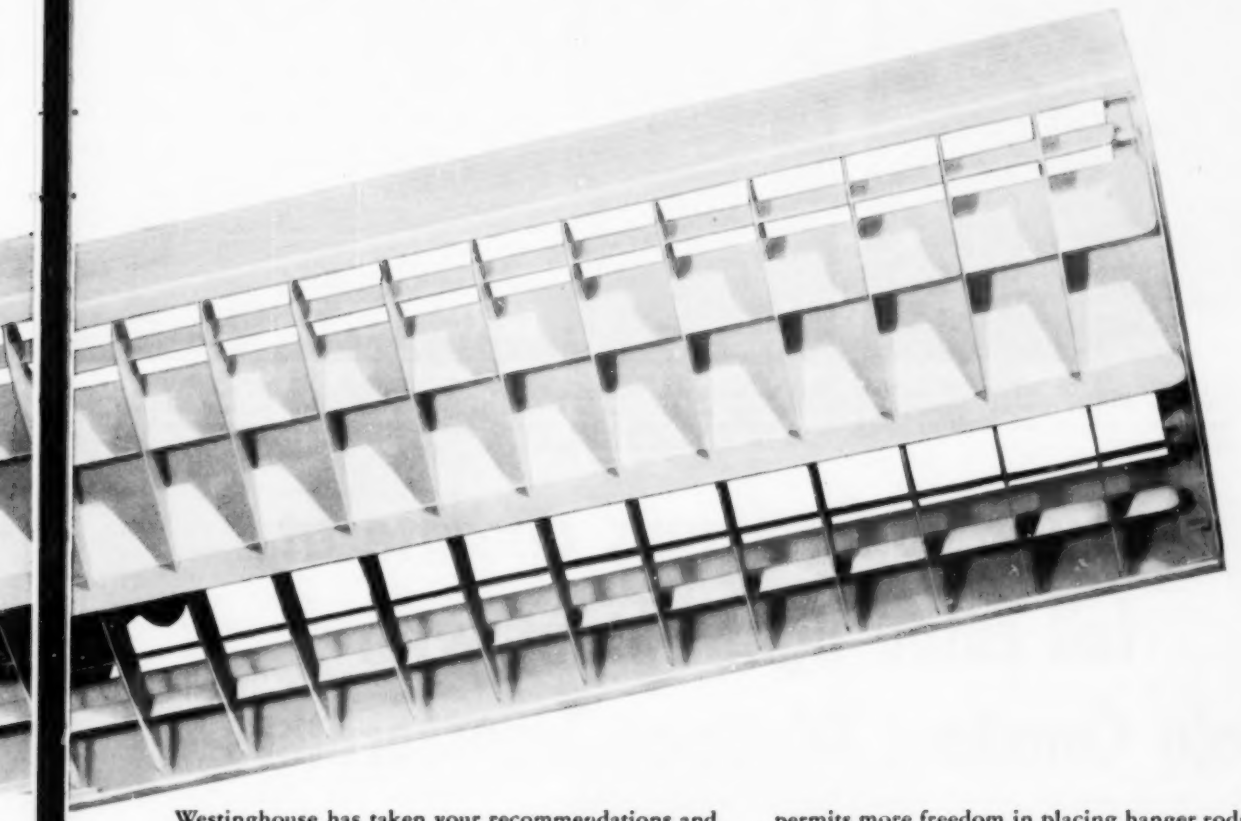
(Continued on page 13A)

Here's the

"For several years, we at Westinghouse have been working with illuminating engineers, architects and electrical contractors to find practical answers to lighting problems involving many different applications. One result of this close co-operation is our new LC luminaire which has been designed on the basis of your recommendations for school, office and store lighting applications."—W. R. Davies, Westinghouse Sales Manager, Commercial, Industrial and Floodlighting.

Westinghouse luminaire you helped design

. . . for schools • offices • stores



Westinghouse has taken your recommendations and incorporated them into the design of this completely new luminaire. One of your requirements was that the usual dark areas at the ends of fixtures be minimized. This was accomplished in the LC design by providing a wrap-around plastic side panel with luminous corners. Another of your requests was for versatility of application in schools, offices and stores where comfortable light and quality illumination are prime essentials. The new LC answers this demand with controlled brightness.

You asked for shallow design—the new LC offers a shallow design which readily adapts to varying requirements, harmonizing with any room architecture.

You asked for ease of installation—the LC has it; one example being the new slide hanger which permits more freedom in placing hanger rods. Units go up faster and installation costs go down.

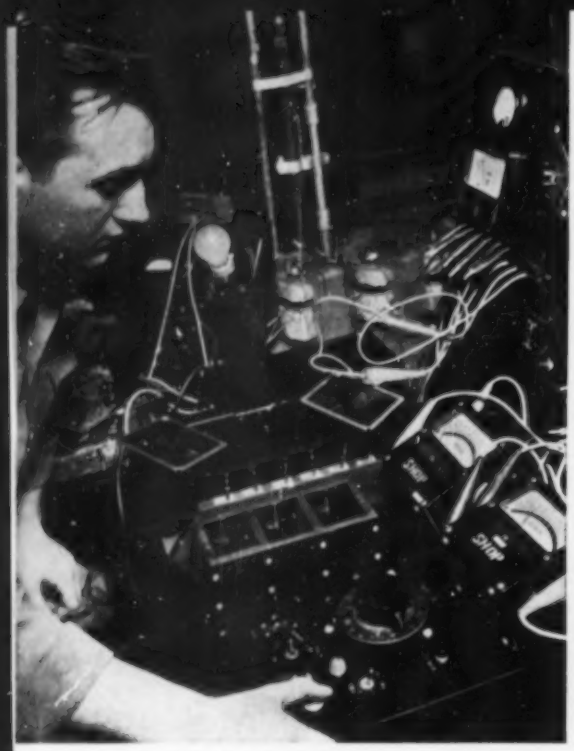
You asked for moderate initial cost—the Westinghouse LC is priced right to meet requirements for quality illumination at a moderate cost.

You asked for low maintenance and operating cost—both are built in the LC. Units are protected from corrosion by the Bonderite process to assure durability. And all ballasts are ETL approved, which means maximum life and minimum maintenance.

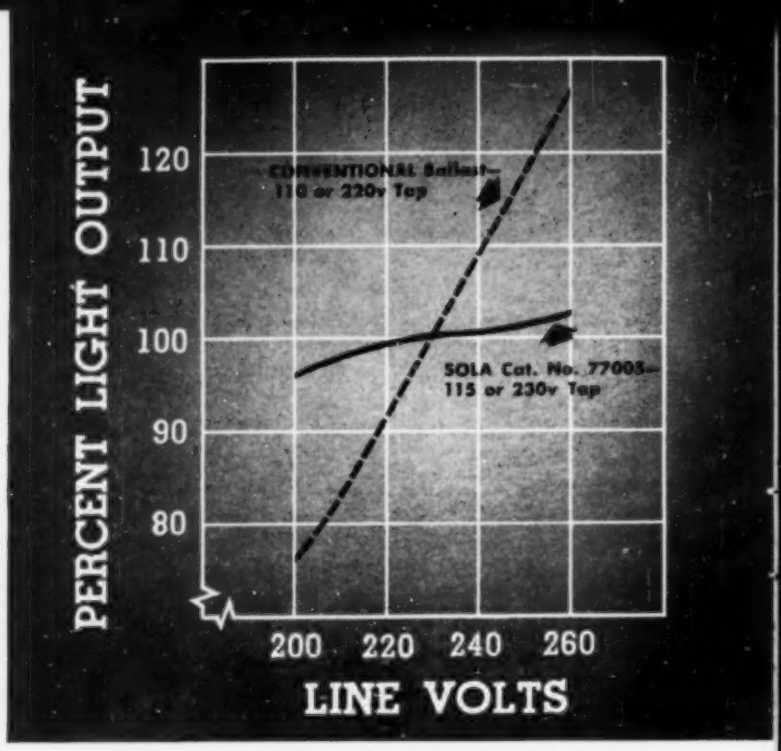
For more information about the new LC—or about our lighting fixture warranty program—call the Westinghouse distributor nearest you. Write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-04362

YOU CAN BE **SURE**... IF IT'S

Westinghouse



PRODUCTION LINE TESTING OF REGULATING ACTION: Every Sola Constant Wattage Mercury Vapor Transformer is individually adjusted and tested to assure regulation of light output.



LIGHT OUTPUT REGULATION COMPARISON: The curves above compare the light output from an EH-1 mercury vapor lamp operating from a conventional non-regulating transformer against a Sola Constant Wattage Transformer under varying values of line voltage.

Mercury vapor lamps operate at full rated light output with Sola Constant Wattage Transformers

You get all the lumens you pay for, when your mercury vapor lamps operate from Sola Constant Wattage Transformers. These regulating ballasts continuously and automatically maintain lumen output within ±2% regardless of line voltage fluctuations as great as 25%.

You benefit from other important operating advantages resulting from the Sola constant wattage circuit:

- Positive starting within the primary ranges of 100/200-130/260v without need for primary taps.
- Negligible starting line current surge, eliminating need for time-delay relays, oversize circuit breakers and oversize wiring.
- Virtual elimination of outages from line voltage drops since primary voltage must fall below 70v on a 115v circuit before lamp will extinguish.
- Protection on open and short circuit by limiting current under abnormal operating conditions (lamp failure or load short circuit).
- Extended lamp life resulting from stabilized operation.

The moderate differential in original cost, over conventional non-regulating ballasts, is often eliminated by installation savings and by continuous high quality of performance you realize from your mercury vapor lighting installation. Write for the facts.

WRITE FOR BULLETIN 3K-MV-208 FOR COMPLETE DATA

SOLA *Mercury Vapor Lamp* **TRANSFORMERS**

REGULATING OUTDOOR

REGULATING INDOOR

CONVENTIONAL INDOOR

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • LIGHTING TRANSFORMERS for All Types of Fluorescent and Mercury Vapor Lamps. • SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • NEW YORK 33: 103 E. 125th St., TRafalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4965 • BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354 CLEVELAND 15: 1836 Euclid Ave., Prospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • Representatives in Principal Cities

Lighting Service Committee Chairman Lee Tayler, at microphone, announces the results of the contest for My Most Interesting Lighting Job. At left, first prize winners Duncan Preston and Floyd Sell heartily congratulate each other; J. J. Tynan, second prize; Louis N. Goodman, third; and Blair Plowman (behind Mr. Manwaring) proxy for Eric Ackland, fourth prize, look equally pleased.

(Continued from page 9A)

come early for choice seats; newcomers soon learn that this practical education with an entertainment coating is an I.E.S. must.

Lighting Competition

It has taken only two years of national operation to establish the "My Most Interesting Lighting Job" contest as one of the most popular as well as practical of I.E.S. projects. This year nine national entries represented finalists of local and regional competitions which were more keenly competed than ever. Finalists in this year's national competition were selected from a total of 194 original entries (last year 118 participated). Every I.E.S. Region held "semi-finals" with Section and Chapter winners competing with one another, the competition in each case being a main feature of the Regional Conference. The program is under the direction of the Lighting Service Forum, Lee E. Tayler, Chairman.

The nine Regional Award Winners competing for the national prize were:

First Prize, $100.00: Floyd Sell and Duncan Preston, Detroit Edison Company, Detroit, Mich., Michigan Section, "Special Application at the Detroit Plating Co."

Second Prize, $50.00: J. J. Tynan, Atlantic City Electric Co., Atlantic City, N. J., Philadelphia Section, "Floodlighting Office Building."

Third Prize, $25.00: Louis N. Goodman, New Orleans, La., New Orleans Section, "Lighting the Lobby and Waiting Concourse of New Orleans Union Passenger Terminal."

Fourth Prize, $15.00: Eric Ackland, Vancouver, B. C., British Columbia Section, "Lighting St. Anselm's Church."

Runners-up: P. A. Ducasse, Quebec City, Que., Quebec Chapter, "Lighting a Furniture Store—Luv-tile Ceiling."

E. H. Schaefer, Wisconsin Electric Power Co., Milwaukee, Wis., Milwaukee Section, "A Light That Is Kind to a Star Sapphire."

Leon T. Johnson, Public Service Electric & Gas Co., Newark, N. J., New York Section, "Lighting Billing Department of Public Service Co."

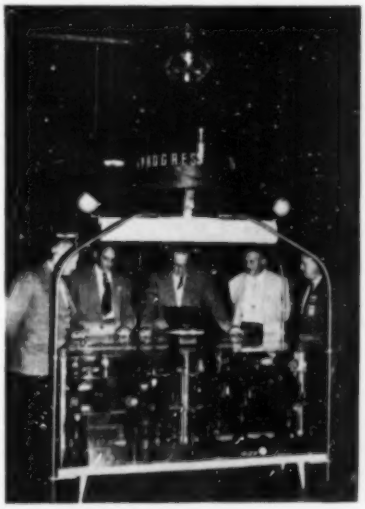
Starr V. Monsees, San Diego, Calif., San Diego Chapter, "Lighting the California Tower."

Floyd Covington, Ft. Sam Houston, Texas, Alamo Section, "Lighting a Drafting Office."

Judges at the national contest were:

A. H. Manwaring — E. M. Strong
D. M. Jones — C. Zersen
C. L. Crouch

Alternate Judges: S. G. Hibben, J. S. Schuchert, R. F. Hartenstein



Historical lamps in this display were discussed by J. M. Rich, center, as part of the celebration of Light's Diamond Jubilee.

A nice innovation at Atlantic City was a special table at the banquet for all contestants and their wives, directly below the speakers table. Special honor was paid to these outstanding engineers and their installations by the entire delegation. Prize checks were awarded by President Manwaring during the banquet.

Of Special Interest

Historical Lamp Exhibit—A wonderful display of historical lamps, some centuries old, collected by Jim Rich of the Philadelphia Electric Co., was an especially happy feature during Jubilee year. Mr. Rich gave interesting lectures on his collection twice each day, and the Philadelphia Electric Co. distributed mounted grain-of-wheat lamps as souvenirs to those attending the lectures. Some 400 people attended the lectures, and hundreds more examined the unique collection.

Residence Lighting Forum—With Katherine T. Goodall, Forum Chairman, presiding, a coordinated display of fabrics, lighting elements for indoor and outdoor living and decorative fixture design attracted considerable attention both in and out of the Society. A group demonstration, with talks, was made of these equipments by Richard Kelly, lighting consultant, Marie Nichols, fabric stylist, and Greta Daniel, Department of Architecture and Design, Museum of Modern Art, New York.

Regional Meetings—A number of I.E.S. Regional V-Ps scheduled local-officer meetings at Atlantic City, in addition to the regular Regional Activities meetings held Tuesday afternoon. Such gatherings of incoming and outgoing Section and Chapter officers within a region augur a high order of organization for next year's local operations. Some of the Regions holding meetings of local officers at Atlantic City were: Southern, East Central, Midwestern and Northeastern.

Committee Meetings—No opportunity was apparently missed by committee chairmen to make the most of committee personnel attendance at the conference. No less than 22 committee meetings were held during the week, and possibly some not reported. In order not to interfere with technical session attendance, these meetings were scheduled for every possible free time, including breakfast, lunch, dinner and all wee hours.

Photo Contest—Arthur Brainerd was chairman of an interesting event—a

(Continued on page 14A)

Incoming and outgoing officers of the Sections and Chapters in the Northeastern Region met at a special luncheon with V-P C. W. McCormick, to discuss Regional activities. Several of the Society's Regions held such meetings.

(Continued from page 13A)

contest for amateur photographers. Contestants competed with everything from a pin hole in a shoe box (almost) to a Graflex, for desirable prizes. At press time prints were still pouring in, with the winner still to be chosen. Win, lose or draw, however, the pictures will serve as a graphic record of the 1954 conference in the Philadelphia Section's History Book.

Daily Newspaper — Outstanding among the host Section's many services to delegates was the daily "newspaper," the *I.E.S. Prevue*. Edited by Ralph Enghouser (Sylvania, Philadelphia) and compiled and produced by the Publicity Committee, the paper was second only to technical paper preprints in demand. It was lively, interesting, and a daily must for all delegates, including ladies. Each session's papers, were thumb-nailed (in advance yet), all daily events were listed, including committee meetings (who, what, when and where), ladies events, sports schedules, etc. Lively gossipy items (sorry, no sensationalism in this press) kept even the dilettante waiting for the next issue. Actually, the mimeographed daily reported the conference so faithfully and so thoroughly it could serve in itself as a record for future planners. Full copies should by all means be included in any "time capsule" for future reference.

Cleveland Treasure Chest — Advance hospitality for the 1955 Conference was dispensed by the Cleveland Section from a special "Cleveland Booth." Every delegate, visitor and guest eventually visited this booth, and with good reason. They all had a key to its "Treasure Chest." About ten of these hundreds of keys fitted the lock, and their lucky owners won very major prizes; like sunlamps, steam irons and other things well worth trying for. Further, the booth furnished a relaxation headquarters, and a handy place to meet. With Ohio carnations to the ladies, key ring souvenirs to all comers, and in many other ways the Cleveland delegation succeeded in putting across their slogan "Come to Cleveland in 1955 — You'll Be Glad You Did."

Light's Diamond Jubilee Celebrations

The Progress Report demonstration was the Society's own celebration of Light's Diamond Jubilee in Atlantic City, but a number of other outstanding Jubilee events were arranged by the Conference Committee.

The world premier showing of the film "The Story of Light," a sound color movie produced in honor of Light's Diamond Jubilee was scheduled September 15 at Haddon Hall, specially for the I.E.S. Conference program. This fascinating film features a new stop-animation technique of puppet shows, and has a music score by the London Symphony Orchestra. Among those attending its premier showing at the Conference were Joe Forest who wrote the script for the film, and Joop Geesink who perfected the stop-motion puppet technique. The film was released to theaters throughout the United States on October 1st, for showing to the public. It is the latest release in a continuous series of "Excursions in Science" films.

The Atlantic City Centennial Association joined with I.E.S. Wednesday evening in a Jubilee celebration which had the public gaping. The whole conference collected on the boardwalk in front of the hotel to see, first the world's largest lamp bulb lighted (General Electric's 75,000-watt king size lamp), with the cooperation of the Atlantic City Electric Co. With this at full brilliance, the Centennial Atlantic City Train passed before the assemblage. This was a scaled down replica of railway trains 100 years ago, ten cars long, and "peopled" with quaint citizens of a century past.

Again with the help of the Atlantic City Electric Co., the city fathers arranged the display of the 800,000,000 beam C.P. carbon arc searchlights on the boardwalk each night, specially for the I.E.S. Conference, and in honor of the Jubilee.

A number of Atlantic City's famous landmarks, including the Boardwalk itself, had been relighted this year as part of the joint celebrations for the city's 100th Anniversary, and Light's Diamond Jubilee. The boardwalk lighting featured two-footcandle minimum maintained illumination from 33,000-lumen mercury lamps. Specially designed luminaires with Type IV distribution and hinged clear glass cover are mounted on the ocean side of the boardwalk on a new architectural pole. Ballasts of new design are mounted at the bases of the poles in water-tight enclosures, and can be seen. Spacing of the units vary from 73 to 82 feet, and the mounting heights from 24 to 30 feet.

Exterior lighting of the power company's main office building was specially installed for this year's celebrations, and was visited by many I.E.S.ers. This was only one of a number of newly lighted attractions, though an outstanding one. (See page 506 of this issue for full description of the installation.) Other Jubilee lighting in Atlantic City included a newly lighted rock garden display on the boardwalk; All Wars Memorial Building; Light House City Park (the famous old Absecon Light), and Atlantic City's new Garden Pier.

Social Program

Packed auditoriums at the technical sessions testified to the importance of the Conference program, but the Entertainment Committee saw to it that all spare moments were light hearted ones. They were even on the job before the conference started, for early arrivals Sunday afternoon. Suitcases were hardly

(Continued on page 16A)

new lighting solutions from ELECTRO SILV-A-KING

MODULAR SQUARES

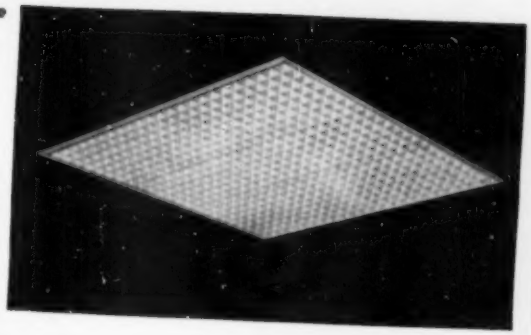
PROBLEM *How to create larger light source areas more economically . . . and how to utilize the same basic fixture throughout the installation.*

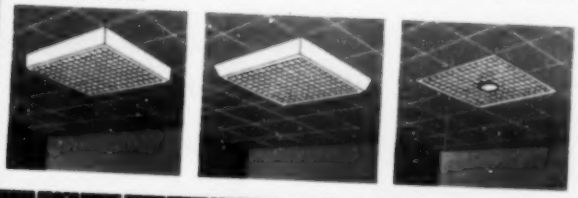
BAYLITE

. . . in modular squares from 2′ x 2′ to 5′ x 5′ for surface or recessed mounting, slimline or fluorescent.

Lighting patterns take on new flexibility with versatile BAYLITES. They can be used individually, in continuous runs, or grouped to create a "louver-all" appearance for large light source areas with a minimum number of fixtures.

BAYLITE units can be recessed or surface mounted . . . and the extremely wide range of possible light intensities allow their use throughout an entire installation so as to achieve a pleasing, uniform effect.





ELECTRO SILV-A-KING BAYLITES are available in several models or to your specifications.

- 2′ x 2′, 2′ x 4′, 4′ x 4′, 5′ x 5′.
- Four, Six, Eight or Ten Lamps • Metal sides or skirts
- Gimbal Ring spots available for PAR-38 lamp
- 35° x 35° shielding—with standard metal louver (Plastic available)
- Rapid Start • Standard Fluorescent • Slimline

TM TROFFER SERIES

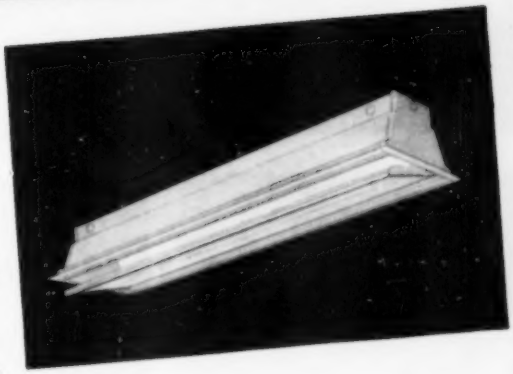
PROBLEM *How to improve the aesthetic qualities of Troffer lighting with a reduction in installation and servicing costs.*

Exclusive

magic frame

TROFFERS

. . . eliminate all exposed, unsightly door screws and latches. Exclusive simplified installation provides "Speedy Latches" in wireway channel for efficient and simple hanging. All electrical components are contained on a removable chained cover.



"MAGIC FRAME" Troffers have no unsightly protuberances to disturb the trim lines of the fixture. Doors lock by gravity, hinge on two concealed pivots for quick maintenance. Completely removable by merely lifting and shifting. For installation, maintenance or removal of the door, there are no screws to loosen, remove or lose . . . doors are interchangeable into any like Magic Frame fixture.

"Magic Frame" Troffers are available with all types of flat glass and plastic diffusers such as: ALBA-LITE, FOTA-LITE, CRYSTAL-LITE, TWINLENS, P4 DIAMOND PATTERN PLEXIGLAS. 2-ft., 4-ft., 5-ft., 8-ft., lengths. Rapid Start • Standard Fluorescent • Slimline.

Write for the name of the ELECTRO SILV-A-KING district manager near you . . . and new Specification Data Catalog.

ELECTRO SILV-A-KING CORPORATION

1535 S. Paulina Street, Chicago 8, Ill. • Spruce and Water Streets, Reading, Pa.

I.E.S. members and guests obviously don't mind being shipwrecked in the Vernon Room of the Haddon Hall. In the photo below, one couple, at left, has succeeded in saving their most precious possessions from the sinking ship.

Mr. and Mrs. Kirk Reid were also rescued.

Conference Executive Committee Chairman A. S. Turner with Mrs. Turner at the party.

At the Shipwreck Party

Mr. and Mrs. Manwaring cast ashore.

(*Continued from page* 14A)

unpacked before the Philadelphia Section's hospitality was felt, starting with an "Early Bird Buffet Supper" in the Wedgewood Room of Haddon Hall, Sunday evening. This was followed by a program of Chamber Music nearby.

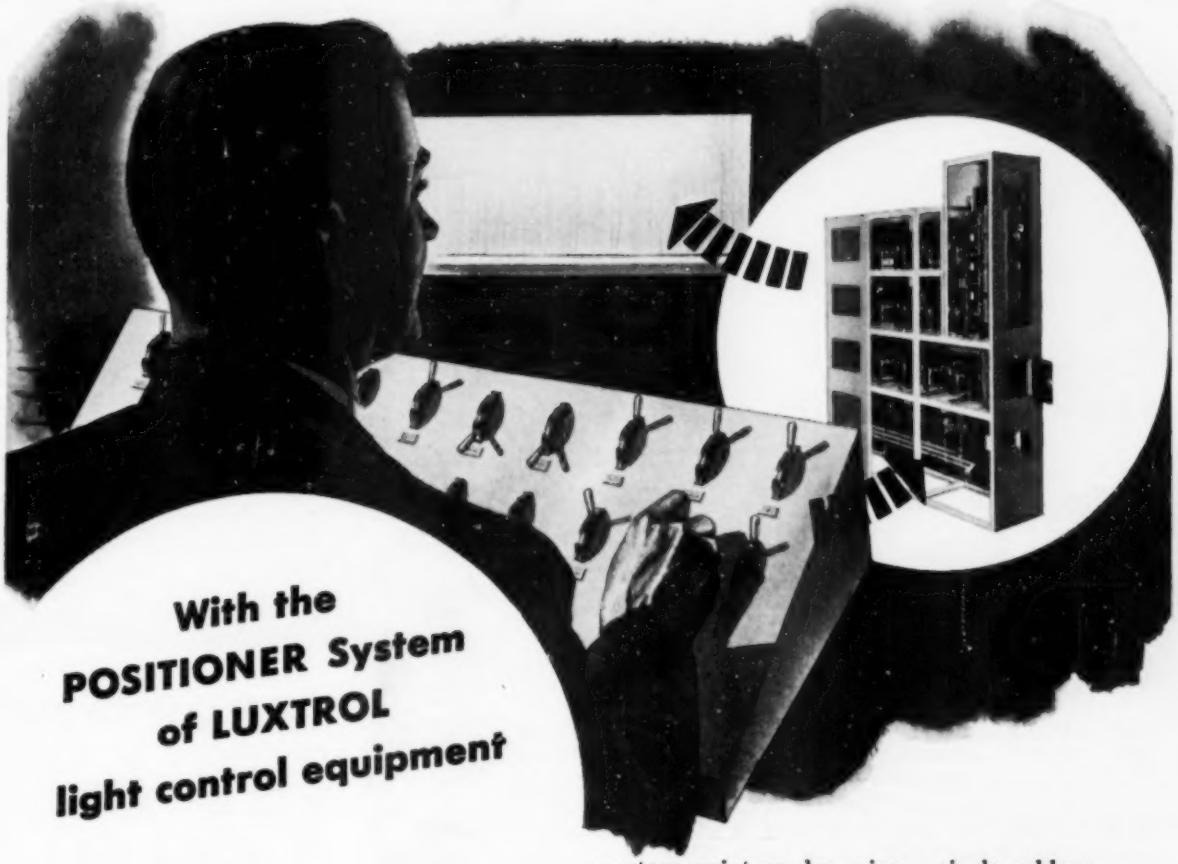
While the President's Reception and Banquet Thursday evening was the highlight of the social events, by far the most high jinks occurred at the "Ship Wreck Party" Monday evening. This had been billed in advance via preconference literature, and hundreds of I.E.S. members came from all over the country, prepared to dress just as they were "when the ship went down." Engineers quite evidently didn't lack imagination! The costumes would have to be seen to be appreciated, but no two were alike. One gal in mufti had a sign on her back "I Missed the Boat." A contest for "Mr. I.E.S." based on talent (plus beauty?) was won by Don Caverly (Sylvania, New York).

Some 710 members and guests attended the reception and banquet, Thursday evening, honoring President and Mrs. A. Homer Manwaring. An impressive moment during the dinner was the ceremony investing the new President, Duncan M. Jones, Mr. Manwaring passing on to him the official gavel, and Mr. Jones in his turn pinning the Past President's Pin to the lapel of Mr. Manwaring's dinner jacket.

Some 12 other Past Presidents of I.E.S. and their wives witnessed the

(*Continued on page* 20A)

Put Your Dimmer Board *In Your Lap*
Sit at the Vantage Point of Your Choice



With the POSITIONER System of LUXTROL light control equipment

The ultimate in lighting control is offered with the POSITIONER Systems. All the facilities of a large manually-operated switchboard are housed in a small, compact control station. You can electrically control any amount of power from miniature selector stations located at any vantage point or, by using a single cable, a selector station can actually become portable. The motor-driven LUXTROL controls are installed in any out-of-way space.

POSITIONER Systems, adaptable to large or small applications, provide pre-set lighting effects in advance, timed to coincide with the most complicated programming.

Send the coupon for detailed information.

See the Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY

5114 Domers Ave., Bristol, Conn.

Manufacturers of: POWERSTAT Variable Transformers • STABILINE Automatic Voltage Regulators • VOLTBOX A-C Power Supplies • LUXTROL light control equipment • VARICELL D-C Power Supplies • Superior 5-WAY Binding Posts

THE SUPERIOR ELECTRIC COMPANY
5114 Domers Ave., Bristol, Conn.

Please send literature on the POSITIONER System of LUXTROL light control equipment.

Name.....

Position.....

Company Name.....

Company Address.....

City.....Zone.....State.....

RECOMMENDED WHERE:

1. Seeing tasks demand 25 footcandles or more.
2. Walls, ceilings, machinery, etc., have good reflectance.
3. You need super-comfortable illumination.
4. Maintenance costs are important.
5. Best lighting is required at reasonable cost.

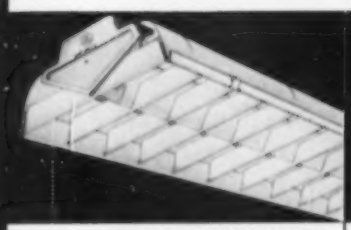
THE REVOLUTIONARY NEW LIFETIME

CFI-25

WITH 25% UPWARD COMPONENT

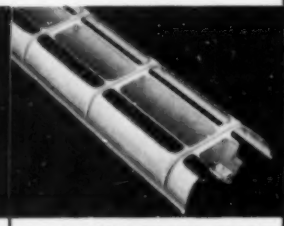
The CFI-25 is more than a new fixture. It is the beginning of a new era of super-comfortable industrial lighting. For the first time, the CFI-25 makes available a rugged, premium quality industrial fixture with all the comfort advantages of 25% uplighting—*within a practical price range!*

See this sensational new development. Compare it—feature for feature—with any other industrial fixture on the market. Notice the full 8-foot, one-piece, porcelain enameled reflectors... the new "bridge-type" ribbed construction... super-comfortable shielding... the many, many features that make the CFI-25 the most modern product in its field. Available for 8 ft. Slimline, 4 ft. Rapid Start and the newly developed 8 ft. High-Output Rapid Start lamps.



20° LENGTHWISE SHIELDING. Optional louver assembly provides excellent visual comfort. Louvers furnished in 4-ft. sections, hinge either side for easy servicing.

30° CROSSWISE SHIELDING. Porcelain reflector provides comfortable 30° crosswise shielding, adds substantial strength and rigidity to the fixture.



NEW RIBBED CONSTRUCTION. Reflectors reinforced by die-embossed ribs between apertures. Ribs add lateral stability, prevent spreading, maintain straight fixture edges.

IMPORTANT!

Here's why *only*

PORCELAIN ENAMEL

is used for CFI reflectors!

An industrial lighting fixture is no better than the wearing qualities of its reflecting surfaces. The lasting qualities of baked enamel reflectors are questionable in industrial applications. *Only porcelain enamel guarantees a lifetime of service at the least cost.*

Porcelain enamel does not decay or change with age because it is *inorganic*—nothing but rock-like minerals that are actually melted and fused to the base metal under extremely high temperature (1400-1600°). The result is a

CFI MEANS COMFORT FOR

CALL OR WRITE YOUR NEAREST DAY-BRITE REPRESENTATIVE FOR THE

THE NEW DAY-BRITE
LIFETIME INDUSTRIAL SERIES—
ONLY INDUSTRIALS WITH FULL
8-FOOT, ONE-PIECE, PORCELAIN
ENAMELED REFLECTORS

THE LIFETIME

CFI-10

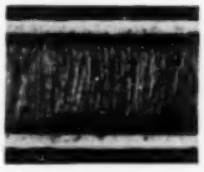
WITH 10% UPWARD COMPONENT

Sets a new high standard for industrial lighting fixtures! 10% uplighting reduces glare and lessens brightness contrasts. Full 8-foot, one-piece, porcelain enameled reflectors featuring new super-rigid ribbed construction. Runs line up perfectly, *stay perfect.* Available for 8 ft. Slimline, 4 ft. Rapid Start and the newly developed 8 ft. High-Output Rapid Start lamps. Engineered and built to give a *lifetime of service.*

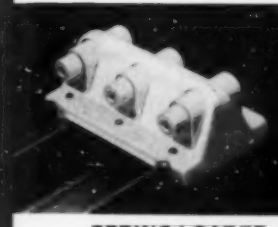
flint-hard, indestructible bond of metal and finish that is unaffected by time, heat, moisture and other harmful elements.

No baked enamel finish can assure you the non-yellowing, noncorrosive reflection surface that porcelain enamel does. There are no tiny surface pores in porcelain enamel. Any dirt or stain is external and is easily wiped away.

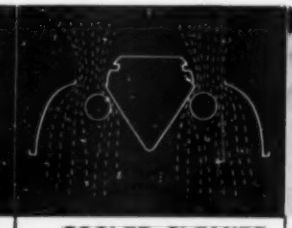
Because of its undisputed superiority, specially formulated porcelain enamel with a reflector factor of 85% or more is the one and only finish Day-Brite uses on the reflection surfaces of the CFI-25 and the CFI-10 ... to make them in fact — as well as in name — a *Lifetime* industrial lighting value.



Microphoto shows how metal and porcelain enamel fuse together to form lifetime bond.



SPRING-LOADED SOCKETS. Firm lamp contact, firm seating. Metal clad for positive alignment and protection against breakage. Individually replaceable.



COOLER, CLEANER OPERATION. Diagram demonstrates "up-draft" action through apertures. Constant flow of air keeps dust from settling, reduces operating temperature.

FAST, SIMPLE MAINTENANCE. Reflectors on or off in seconds, fasten to channel by hand-operated 2" wing-nuts. Porcelain enamel wipes clean quickly, is noncorrosive.

INDUSTRY!

COMPLETE QUALITY STORY

"DECIDEDLY BETTER"
DAY-BRITE
Lighting Fixtures

Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

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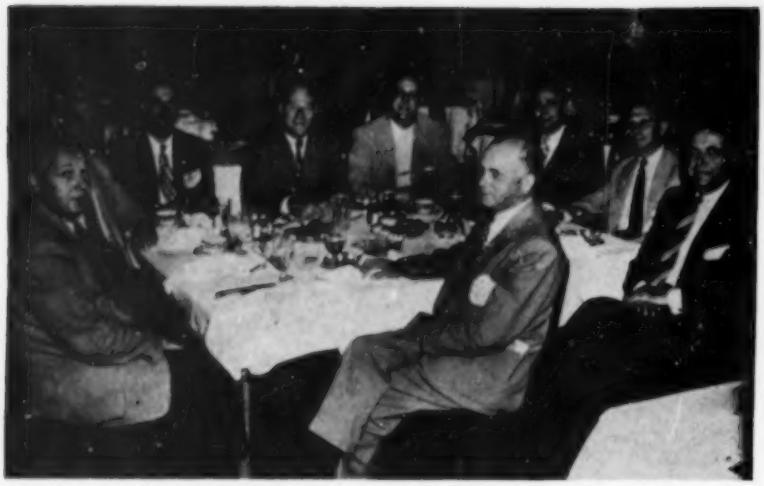


Organizational meeting of a Canadian National Committee on the C.I.E. (International Commission on Illumination) was held September 14, during the I.E.S. Conference. Left to right around the table are Hedley F. Davidson; M. B. Hastings, I.E.S. Canadian Regional Vice-President; G. F. Dean; Carl A. Atherton, Honorary Secretary of C.I.E.; R. C. Allison; T. D. Wakefield; Arthur A. Brainerd, President of the U. S. National Committee; Dr. Ward Harrison, President of C.I.E.; and J. W. Bateman. Mr. R. C. Allison, T. Eaton Co., Ltd., is acting as Chairman pro tem in activating the Canadian committee for direct representation of Canada in establishing international lighting standards rather than through the U. S. National Committee as is currently done.

(Continued from page 16A)

affair from a special table reserved for them, immediately below the speakers table.

Golf, fishing, horse-racing and numerous seashore activities were also available for relaxing moments, with all arrangements smoothed by Entertainment Committee members.

Ladies Program

While visiting ladies could and did participate in all of the social activities listed above, they had their own program as well, under the capable direction of Mrs. Katherine Goodall of Philadelphia Electric Company. The huge sunporch of Haddon Hall was turned over to them for a card room and general meeting place during the entire week, with local members' wives serving as hostesses. Coffee was served here every morning. During this interlude Mrs. British Columbia Section became fast friends with Mrs. New England Section, and it's a sure thing that Christmas card lists have grown longer all over the country.

On Tuesday women guests at the Conference attended a luncheon arranged for them at Smithville Inn, with a trip afterward to the Brighton Orchid Farm. Another luncheon Thursday afternoon, featured a millinery show.

While the Residence Lighting technical session, and the Residential Forum program were not intended as part of the ladies' program, many women guests attended these meetings nevertheless.

Awards

Another interesting event during the Banquet on Thursday evening was the presentation of several awards, made by President Manwaring. In addition to the checks for the "My Most Interesting Lighting Installation" competition already reported, other awards were:

Membership Prize: First prize for Group I went to the Michigan Section, Floyd Sell accepting the check. New York Section came in second in this group.

Group II winner was the Capital Section, for whom Harold V. Oerting accepted the check. Second place was won by the Toronto Section.

Group II winner was Arizona Chapter; Tennessee Valley came in second.

For Group IV, San Diego Chapter won first prize; Utah Chapter was second.

Travel Gavel: The gavel and anvil, awarded for Section or Chapter attendance at the Conference, in percentage of the total Section membership, times the miles traveled, was again won by the New Orleans Section. They have carried this gavel to the Conference, and back to their Section every year since '51. This year they won with a total of 8 New Orleans members on hand, Arthur Levy, their new Chairman accepting the award once again for their Section. No prize is given for other than first place in the attendance competition, but Inland Empire was second in this accounting, and San Diego Chapter third.

Sustaining Activity: A prize was awarded for the greatest number of sustaining member additions during the year. For Group I, Chicago Section took first prize; for Group II, Toronto Section was first.

Golf Law Trophy: Charles H. Goddard, a Past President of I.E.S. was the winner this year of the I.E.S. President's Cup, also known as the Law Trophy. This silver cup was presented to the Society by Clarence L. Law, President in 1923-24, and is placed in competition at each Conference on an 18-hole handicap basis.

Regar Cup: Another keenly contested golf trophy is the Regar Cup, which has been in competition since 1937, a gift of the late G. B. Regar, President in 1936-37. The trophy is awarded for low gross Section or Chapter team of four, and was won this year by the Philadelphia Section. E. Fred Bahls accepted the cup for his Section.

President's Certificate: President Manwaring was himself the recipient of a handsome Certificate of Appreciation, signed by all members of Council, in recognition of his outstanding service to the Society.

Incidental Items

There were a number of things at the 1954 Conference well worth recording, for future reference and current interest, which don't fall naturally into the program items mentioned. For instance:

A running quiz game "Who Said That?" in each issue of the daily mimeographed "newspaper" with clues leading to the answer. Sample questions: Who said — " . . . If the Illuminating Engineering Society stands for anything, it stands for the preservation of that best of all of the God-given five senses, the sight. I have sometimes thought that instead of the name Illuminating Engineering Society, we should call it the Society for the Preservation of Human Eyesight." Answer given in next day's issue — Conrad P. Bond. Who said — " . . . if the electric lighting is used, the gas mantles are seldom kept up on the gas outlets. While open gas burners would of course, avoid this objection, I feel that personally I would use candles, if necessary, to provide emergency equipment." Answer — said in 1916 by George Stickney.

(Continued on page 23A)

NOW! A material especially designed for luminous ceilings

Translucent Ultron rigid vinyl sheet gives glareless, shadowless light diffusion

Workman slides continuous corrugated ULTRON rigid vinyl sheeting into supporting channels in new classroom for Franklin Elementary School, West Newton, Mass.

After careful comparison of available materials, Franklin Elementary School's architect and lighting engineer chose new ULTRON rigid vinyl sheet for luminous ceilings in the school's unique, demountable pentagonal-shaped classroom additions. Here's why:

Luminous ceilings made of ULTRON rigid vinyl sheeting offer *maximum* light diffusion with a *minimum* of shadows. Used in association with an effective fluorescent lighting system, the luminous ceiling gives even, shadowless light diffusion in all parts of the classroom. In addition, ULTRON rigid vinyl sheeting has greater resistance to darkening or blackening caused by prolonged exposure to ultra-violet rays.

Luminous ceilings made of ULTRON rigid vinyl sheeting hide unsightly pipes and ducts, reduce building costs. Sprinkler system nozzles can be concealed because ULTRON rigid vinyl sheeting gives way at temperatures slightly below that necessary to set off automatic sprinkler systems. These lightweight luminous ceilings are very easy to disassemble for quick cleaning in a mild detergent solution. And when destaticized, minimum maintenance is required.

For full information on new ULTRON rigid vinyl sheeting, write MONSANTO CHEMICAL COMPANY, Plastics Division, Room 6301, Springfield 2, Mass.

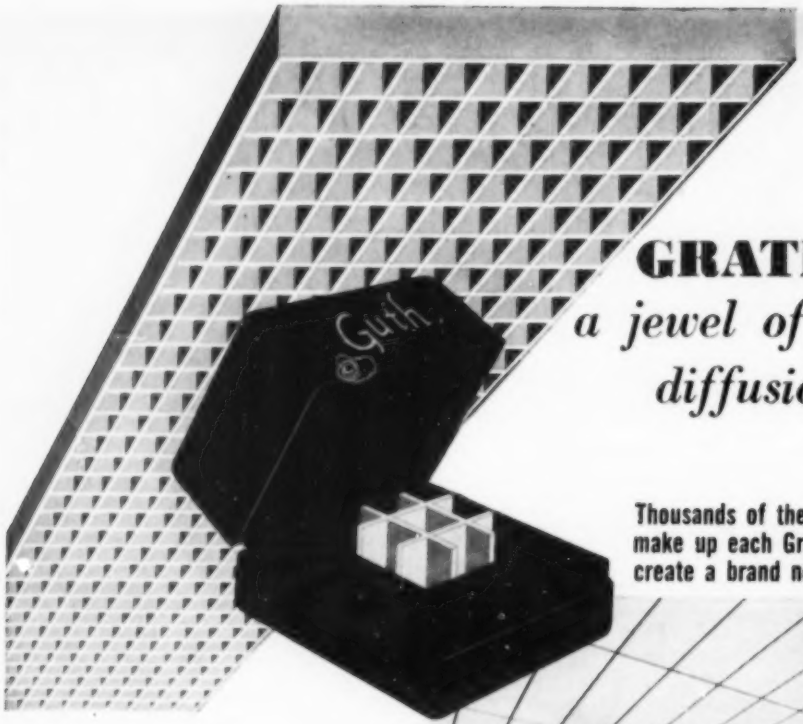
Note that functional, beautiful luminous ceilings made of ULTRON rigid vinyl sheeting completely diffuse the light—no "bright spots" or shadows!

Luminous ceiling fabricated by Marlux Corporation, Somerville 43, Mass.

MONSANTO

SERVING INDUSTRY...WHICH SERVES MANKIND

Meet more Monsanto products on CBS-TV's "Morning Show"



GRATELITE...
a jewel of sight-saving diffusion power

Thousands of these cubes make up each GrateLite panel... and create a brand new kind of light.

FINE DIFFUSION... the cubicles appear to blend into one solid, luminous mass. Its surface is 30% vertical members!

HIGH EFFICIENCY..., translucency and openness, tapered vanes, shallowness (3/8") — these assure highest illumination values with low absorption factor.

LOW BRIGHTNESS ... its vanes with contrasting cubicles and "in shadow" characteristics render light of extremely low brightness without an effect of dimness.

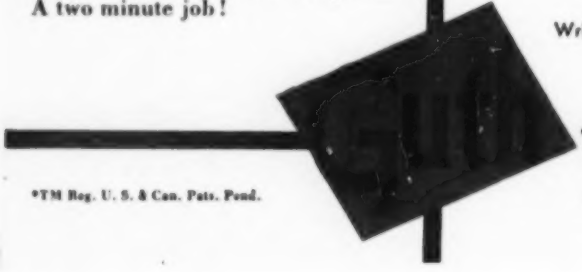
EXCELLENT SHIELDING ... exclusive 45° x 45° shielding method (with 3/8" cubes) gives greater eye protection than any other louver with larger openings.

LOW MAINTENANCE ... GrateLite *stays* clean — bugs and dust drop right through. Quick, easy washing restores brand new luster every time. A two minute job!

AND MORE! GrateLite's closely spaced vanes make it rugged to stand severe usage. It provides efficient AIR CONDITIONING DIFFUSION... and filters out a portion of room noise.

It's all in the sight-saving cubes—and only GrateLite has them!

Write for free booklet "The GrateLite Story" today.



THE EDWIN F. GUTH COMPANY ST. LOUIS 3, MO.

Leaders in Lighting since 1902

*TM Reg. U. S. & Can. Pats. Pend.

(*Continued from page* 20A)

An information booth was maintained on the Conference Headquarters floor, with a bulletin board which proved useful for posting messages. The booth was manned by local committee men throughout the week, for the convenience of delegates.

A complete display of I.E.S. publications, with order blanks, enabled delegates to bring themselves up to date on Society literature.

Except on the night of the banquet, all hospitality rooms closed down at midnight to encourage delegates to sufficient rest.

The list of advance registrations received by each delegate as he arrived, was supplemented each day in the "newspaper" with new arrivals. With the advance list plus the daily additional list, every member had a compete roster of those attending.

Where Credit Is Due

Philadelphia Section was host to the Conference, with assists from numerous members of the East Central Region. The chairmen of the committees listed below had the responsibility for the exceptional success of this conference, and their work was greatly lightened by the following personnel:

National Technical Conference Committee 1953-1954
Chairman, C. N. Lsupp
Wisconsin Electric Power Co.
Milwaukee, Wis.

C. L. Amick	A. D. Hinckley
C. J. Berry	L. E. Tayler
W. W. Booth	A. S. Turner
G. F. Dean	L. C. Twichell
J. C. Forbes	M. N. Waterman
R. F. Hartenstein	R. M. Zabel

Conference Executive Committee
Chairman, A. S. Turner
General Electric Co., Philadelphia, Pa.

A. A. Brainerd	K. T. Goodall
C. J. Berry	R. M. Hoot
F. L. Calvi	T. W. Lauer
M. Cole	D. D. Lees
H. A. Croasdale	H. J. Martin
I. Dixon	C. C. Shotwell
S. W. Drucker	J. J. Tynan

Papers Committee
Chairman, R. M. Zabel
Westinghouse Electric Corp.
Bloomfield, N. J.

L. E. Barbrow	G. Gilleard
L. J. Buttolph	B. F. Greene
H. G. Clum	W. P. Lowell, Jr.
C. L. Cottrell	G. A. Trosper
H. L. Wright	

Lighting Service Committee
Chairman, L. E. Tayler
Detroit Edison Co., Detroit, Mich.

P. H. Hildebrand	D. D. Lees
R. Taylor	

Attendance and Publicity Committee
Chairman, D. D. Lees
Atlantic City Electric Co.
Atlantic City, N. J.

L. Albertson	E. F. Bahls
R. R. Enghouser	F. S. Hutter
E. R. Laws	J. W. Lee, Jr.
E. Lowenstein	W. R. Mackinney
W. McCouch	W. S. Meyers

Entertainment Committee
Chairman, T. W. Lauer
Rumsey Electric Co.
Philadelphia, Pa.

M. I. Allen	R. S. Bucher
E. H. Henrie	A. W. Hopkin
F. M. Pyle	L. C. Roe

Historical Committee
Chairman, A. A. Brainerd
Philadelphia Electric Co.
Philadelphia, Pa.

F. N. Cooper	C. Rudolph

Jubilee Celebration Committee
Chairman, C. C. Shotwell
Philadelphia Electric Co.
Philadelphia, Pa.
C. Behler

Ladies Reception Committee
Chairman, Mrs. K. T. Goodall
Philadelphia Electric Co.
Philadelphia, Pa.

Mrs. C. J. Berry	Mrs. A. A. Brainerd
Mrs. F. L. Calvi	Mrs. H. A. Croasdale
Mrs. M. Cole	Mrs. J. B. Derr
Mrs. I. Dixon	Mrs. S. W. Drucker
Mrs. W. P. Graham	Mrs. R. M. Hoot
Mrs. T. W. Lauer	Mrs. D. D. Lees
Mrs. H. J. Martin	Miss E. B. Murray
Miss M. Salter	Mrs. C. C. Shotwell
Mrs. P. B. Thorne	Mrs. A. S. Turner
Mrs. J. J. Tynan	Mrs. L. Winters

LIGHTING CALENDAR

Society Events

December 9, 1954 — Meeting of I.E.S. Council, New York, N. Y.

February 10, 1955 — Meeting of I.E.S. Council, New York, N. Y.

March 31 - April 1, 1955 — Southern Regional Conference, Ft. Harrison Hotel, Clearwater, Fla.

April 3-5, 1955 — Southwestern Regional Conference, Gunter Hotel, San Antonio, Texas.

April 11-13, 1955 — Inter Mountain Regional Conference, Westward Ho Hotel, Phoenix, Arizona.

April 14-15, 1955 — South Pacific Coast Regional Conference, Statler Hotel, Los Angeles, Calif.

April 25-26, 1955 — Pacific Northwest Regional Conference, Harrison Hot Springs Hotel, Harrison Lake, B. C.

May 2-3, 1955 — Midwestern Regional Conference, Edgewater Beach Hotel, Chicago, Ill.

May 12-13, 1955 — Canadian Regional Conference, Hotel Mount Royal, Montreal, Que.

May 19-20, 1955 — East Central Regional Conference, Abraham Lincoln Hotel, Reading, Pa.

June 10-11, 1955 — Northeastern Regional Conference, Ft. William Henry Hotel, Lake George, N. Y.

September 12-16, 1955 — Illuminating Engineering Society, National Technical Conference, Hotel Statler, Cleveland, Ohio.

Industry Events

November 8-11, 1954 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 15-17, 1954 — American Standards Association, 5th National Conference on Standards and 36th Annual Meeting, Hotel Roosevelt, New York, N. Y.

November 18-19, 1954 — National Farm Electrification Conference, Schenectady, N. Y.

November 22-23, 1954 — National Association of Lighting Maintenance Contractors, Southeastern Regional Conference, Georgia Hotel, Atlanta, Ga.

November 28 - December 3, 1954 — The American Society of Mechanical Engineers, Annual Meeting, Statler Hotel, New York, N. Y.

January 7-11, 1955 — National Retail Industry Show, Madison Square Garden, New York, N. Y.

January 31 - February 4, 1955 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York, N. Y.

March 13-18, 1955 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

April 17-22, 1955 — Society of Motion Picture and Television Engineers, 77th Semiannual Convention, The Drake Hotel, Chicago, Ill.

May 10-12, 1955 — Chicago Electrical Industry Show, Conrad Hilton Hotel, Chicago, Ill.

May 11-13, 1955 — Pacific Coast Electrical Association, Inc., Annual Convention, Palace Hotel, San Francisco, Calif.

May 12-13, 1955 — Public Utilities Advertising Association, Annual National Convention, Sheraton Hotel, Chicago, Ill.

June 27 - July 1, 1955 — American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.

August 15-19, 1955 — American Institute of Electrical Engineers, Pacific General Meeting, Butte, Montana.

October 3-7, 1955 — Society of Motion Picture and Television Engineers, 78th Semiannual Convention, Lake Placid Club, Essex County, N. Y.

October 3-7, 1955 — American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago, Ill.

October 5-7, 1955 — Canadian Electrical Manufacturers Association (11th Annual Meeting), Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

October 17-21, 1955 — National Safety Council, 43rd National Safety Congress & Exposition, Chicago, Ill.

October 24-26, 1955 — 37th Annual Meeting and Sixth National Conference on Standards, American Standards Association, Washington, D. C.

(*Continued on page* 24A)

(Continued from page 23A)

Lighting and Decorations Committee
Chairman, F. L. Calvi
Calvi Electric Co.
Atlantic City, N. J.

J. Adler — W. G. Brown
P. R. Holmes

Reception Committee
Chairman, H. J. Martin
Sylvania Electric Products Inc.
Philadelphia, Pa.

C. F. Bond — G. W. Howson
W. H. Rademacher — J. F. Roberts

Transportation Committee
Chairman, S. W. Drucker
Independent Wiring Co.
Philadelphia, Pa.

R. H. Feltwell — W. E. Hawkins
H. A. Williams

Hotel Committee
Chairman, H. A. Croasdale
Westinghouse Electric Corp.
Philadelphia, Pa.
T. G. Broussard

Hotel Conference Rooms Sub-Committee
Chairman, W. P. Graham
Philadelphia Electric Co.
Philadelphia, Pa.

J. T. Fite, Sr. — C. Gershanic
H. C. Jones — R. Richardson

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Chairman, J. B. Derr
J. B. Derr Associates
Philadelphia, Pa.

W. E. Guertler — A. Hutton
V. W. Kafka — W. E. Tribit

Hotel Reservations Sub-Committee
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W. Fowler — J. R. McCullough

Hotel Technical Sessions Sub-Committee
Chairman, L. Winters
Hopkins Brothers, Inc.
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J. H. McQueston — J. W. Shively
E. Zimmers

Sports Committee
Chairman, I. Dixon
Atlantic City Electric Co.
Atlantic City, N. J.

J. Chew — J. H. Rich
A. Victor — W. Wyman

Finance Committee
Chairman, M. Cole
Philadelphia Electric Co.
Philadelphia, Pa.
J. B. Taylor

Technical Program

Opening Session

Monday Morning, September 13
Vernon Room — Haddon Hall

Presiding: Charles N. Laupp, Wisconsin Electric Power Co., Chairman, National Technical Conference Committee.
Address of Welcome — G. R. Swinton, City Engineer, Atlantic City, N. J.
Response — Charles N. Laupp, Chairman, National Technical Conference Committee.
Electrical Industry Welcome — B. L. England, President, Atlantic City Electric Co.
Response — A. H. Manwaring, President, Illuminating Engineering Society.
Report of General Secretary — M. N. Waterman, Westinghouse Electric Corp.
President's Address — A. H. Manwaring, Vice-President, Philadelphia Electrical and Manufacturing Co
President-Elect's Address — D. M. Jones, Curtis Lighting Co. of Canada, Ltd.
Presentation of Fellows — President A. H. Manwaring.
I.E.S. Medal — Its Purpose and History — Walter Sturrock, General Electric Co., Medal Committee.
— Awarding of I.E.S. Gold Medal to Dr. Erwin F. Lowry, Manager, Engineering Laboratories, Lighting Division, Sylvania Electric Products, Inc., by President A. H. Manwaring.

Technical Session — Environment

Monday Afternoon — September 13
Vernon Room

Session Chairman: R. M. Zabel, Westinghouse Electric Corp.
The Acoustic Environment — Robert B. Newman, Consulting Engineer, Bolt Beranek and Newman, Inc., Cambridge, Mass.
The Thermal Environment — Nathaniel Glickman, Consulting Engineer, Miami Beach, Florida.
The Luminous Environment — L. C. Kalff, General Art Director, N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands.

Light Sources

Tuesday Morning (Parallel)
September 14
Vernon Room

Session Chairman: W. P. Lowell, Jr., Sylvania Electric Products, Inc.
Discussion Organizer: L. J. Buttolph, General Electric Co.
Short Arc Lamps and Their Applications — Wolfgang E. Thouret and George W. Gerung, Westinghouse Electric Corp., Bloomfield, N. J.
Determinants of Fluorescent Lamp Life — R. N. Thayer, General Electric Co., Cleveland, Ohio.
Some Problems Involved in the Design of Fluorescent Lamps, Edwin F. Lowry, W. Calvin Gungle and Charles W. Jerome, Sylvania Electric Products Inc., Salem, Mass.
Design of High Output Fluorescent Lamps — A. C. Barr and W. J. Karash, General Electric Company, Cleveland, Ohio.

Residence Lighting

Tuesday Morning (Parallel)
September 14
Rutland Room

Session Chairman: N. H. Vacha, John C. Virden Co.
An Analysis of Twelve Solutions to a Home Lighting Problem — Laurence Schmeckebier, Cleveland Institute of Art, George Danforth, Western Reserve University, and Karl Staley, General Electric Company, Cleveland, Ohio.
Home Lighting and Home Decoration — C. Eugene Stephenson, President, American Institute of Decorators, New York.

Quantity and Quality

Tuesday Afternoon — September 14
Rutland Room

Session Chairman: Dean Farnsworth, U. S. Naval Medical Research Laboratory.
Quantity of Illumination — H. R. Blackwell, Vision Research Laboratory, University of Michigan, Ann Arbor, Mich.
Quality of Lighting — S. K. Guth, General Electric Co., Cleveland, Ohio.
Color and Seeing — Harry Helson, University of Texas, Austin, Texas.

Progress Report

Tuesday Evening — September 14
Vernon Room

Presiding: E. W. Beggs, Westinghouse Electric Corp., Bloomfield, N. J., Chairman, Progress Committee.
Progress Committee Session.
Celebrating Light's Diamond Jubilee and Report of Lighting Progress 1953-54.

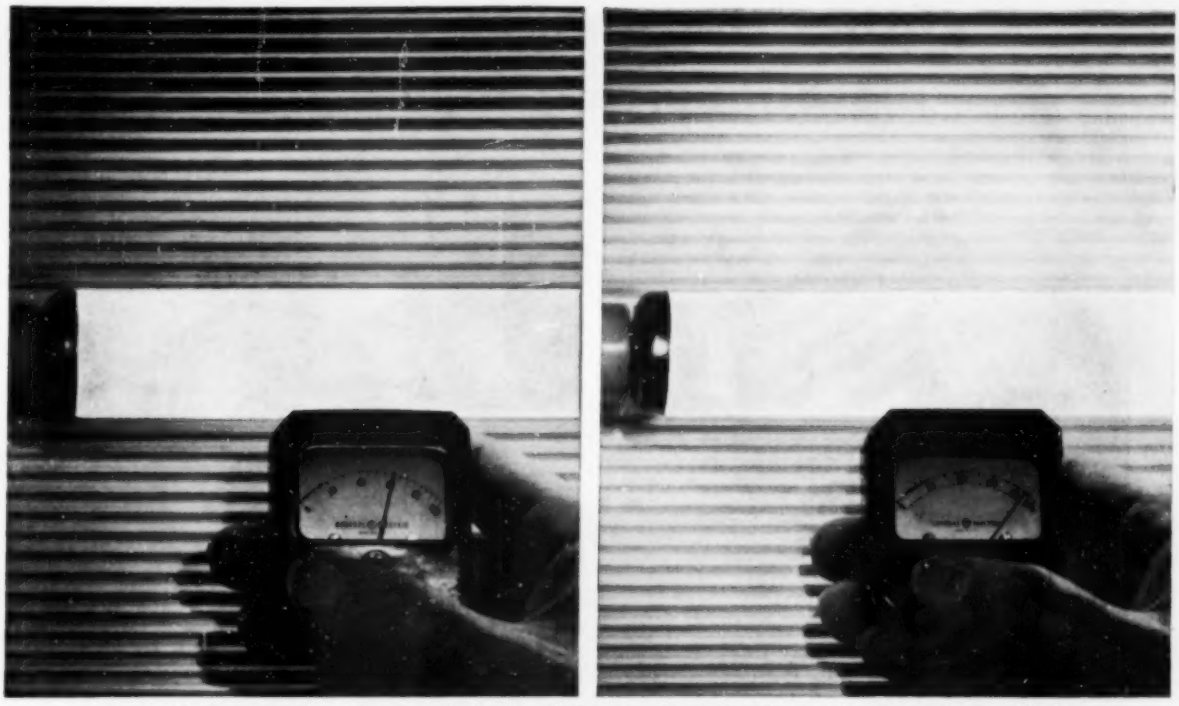
Lighting Calculations

Wednesday Morning — September 15
Vernon Room

Session Chairman: B. F. Greene, Consulting Engineer.
Discussion Organizer: George Gilleard, Curtis Lighting Inc.
Brightness and Illumination by Inter-Reflections in Enclosures — Robert S. Wiseman, University of Illinois, Urbana, Ill.
A Modified Method of Daylighting Design — W. J. Arner, E. W. Conover and J. W. Griffith, Libbey-Owens-Ford Glass Co., Detroit Steel Products, and Department of Electrical Engineering, Southern Methodist University, Dallas, Texas, respectively.
Measured Utilization Factors, Wentworth M. Potter and A. H. Russell, General Electric Co., Cleveland, Ohio.

(Continued on page 27A)

LOOKING hopefully to the formation of a new I.E.S. Chapter, South Georgia and North Florida members held their second organizational meeting in Valdosta, Georgia, September 17. Temporary Chairman was W. H. Sadler, of Georgia Power and Light Co.; and speaker of the evening was J. S. Gracey, of the Florida Power Corp., who spoke on the "History of the I.E.S.; Its Functions and Operations, and What the Society Can Do for Me." Attendance at the meeting was 42.



Regular slimline, left, gives 620 units of light. New High Output Rapid Start lamp, right, gives 840 units of light.

NEW GENERAL ELECTRIC FLUORESCENT LAMP GIVES ⅓ MORE LIGHT THAN ANY PREVIOUS FLUORESCENT

LIGHTS ALMOST INSTANTLY—General Electric announces the most important advance in fluorescent lighting in 10 years: the new High Output Rapid Start fluorescent lamp. The 96-inch High Output lamp gives 36% more light than the most powerful G-E fluorescent lamp previously available.

For new installations, General Electric High Output lamps offer this ⅓ bonus of light without increasing the number of fixtures or maintenance costs.

This big increase in light, with no increase in lamp size, has been achieved through a special cathode developed by General Electric which permits a boost in lamp wattage to 100. Because the cathode is of the famous General Electric triple coil design, these Rapid Start lamps light up almost instantly. General Electric High Output lamps have a rated life of 7,500 hours, the same as all General Electric general lighting fluorescent lamps.

A new G-E base and socket design protects the lamp contacts by recessing them. A simple push-pull sets the lamp in its fixtures.

HAS VARIETY OF USES

The new General Electric High Output fluorescent lamp is especially suited for use in areas with high ceilings, in factories, warehouses, offices and stores. Also in store windows, showcases and other places where you want higher lighting levels in keeping with the modern trend. New fixtures designed for the G-E High Output lamp will soon be available from a number of lighting fixture manufacturers.

For information, write to Lamp Division, General Electric Company, Dept. 166-1E-11, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

*Lighting that makes the nation's most important buildings come alive

Williamsburgh Savings Bank, Brooklyn
Troffer Series 25-4 with Metal Louvers
Trowler & Sushan, architects–engineers;
Lincraft Constr. Corp., gen'l contractor;
Standard Light'g Fix. Co.

Hydrox Sealtest Ice Cream Co., L.I.C.
Troffer Series 25-1; 5032 Controlens*
L & P Elec. Constr. Co., elec. contractor

Lever House, New York City
No. 9015 Controlens* Shielded Troffers
Skidmore, Owings & Merrill, architects;
Silverman & Smith, electrical engineers;
Geo. A. Fuller Co., general contractors;
Fishbach & Moore, electrical contractors.

*® HOLOPHANE CO., INC.

SOME IMPORTANT ORGANIZATIONS NOW USING PHILITE "SERIES 25" TROFFERS

Bethlehem Steel Corp.
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General Foods Corp.
Johns-Manville Corp.
Link-Belt Co.
Newark Airport
NYC Public School No. 172
Rohm & Haas Co.
University of Pennsylvania
Warner-Hudnut, Inc.
Webb & Knapp, Inc.

Leading organizations in every field of endeavor are specifying Ruby-Philite today to gain maximum efficiency from their lighting installations. They have found that Ruby-Philite luminaires provide desired levels of illumination with a minimum of distracting glare or brightness . . . often at substantial savings realized thru higher luminaire efficiency and lower installation costs. You, too, will find it easier to make your buildings come alive with proper lighting when you specify Ruby-Philite. Write now for complete catalog data.

*SERIES 25 TROFFERS • Available in 8 different shieldings for recess installation in any type of ceiling.

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PHILITE

MEMBER N.E.M.A.

Ruby-Philite Corp.

32-02 QUEENS BLVD., LONG ISLAND CITY 1, N. Y.

(Continued from page 24A)

Residence Lighting Forum

Wednesday Morning — September 15

Rutland Room

Presiding: Katharine T. Goodall, Forum Chairman, Philadelphia Electric Co., Philadelphia, Pa.

New Light on Modern Living —
A group presentation with demonstration and slides by Richard Kelly, Lighting and Design Consultant; Marie Nichols, Fabric Stylist and Creator; and Greta Daniel, Department of Architecture and Design, Museum of Modern Art, New York City.
A coordinated Display and discussion by three persons prominent in design of architecture, fabrics, specific purpose fixtures and lamps in today's lighting for indoor and outdoor living together with exhibition of decorative fixture design throughout the world.

Wednesday Evening — September 15

Haddon Hall Lounge

Talk on Historical Lamps — James H. Rich, Philadelphia Electric Co., Philadelphia, Pa.

Rutland Room

World Premier Presentation of "Story of Light" — Technicolor-sound film introduced by A. S. Turner, General Electric Co., Philadelphia, Pa.

Boardwalk

Atlantic City's Centennial Train
Lighting of 75-kw Lamp.

Lighting Service Forum

Thursday Morning — September 16

Vernon Room

Presiding: Lee E. Tayler, Detroit Edison Co., Detroit, Mich.
"My Most Interesting Lighting Job Contest."

Street Lighting

Thursday Afternoon (Parallel)

September 16

Viking Room

Session Chairman: C. H. Rex, General Electric Co.
Discussion Organizer: G. K. Glass, The Detroit Edison Co.
Electric Discharge Lamps in Street Lighting Service — J. W. Young, New England Power Service Co., Boston, Mass.
Operation of Mercury Vapor Lamps on Series Street Lighting Circuits — W. A. Ogiesbee and M. E. Keck, Westinghouse Electric Corp., Cleveland, Ohio.
The Diamond Jubilee of 1954 and Its Effect on Street Lighting of Tomorrow—W. Earle Hawkins, Atlantic City Electric Co., W. S. Till and D. W. Rowten, Westinghouse Electric Corp., Bloomfield, N. J., and Cleveland, Ohio.

Work Area Lighting

Thursday Afternoon (Parallel)

September 16

Vernon Room

Session Chairman: J. R. Chambers, Benjamin Electric Mfg. Co.
Discussion Organizer: A. A. Brainerd, Philadelphia Electric Co.
Lighting for Visual Performance in a TV Set Assembly Plant — R. M. Smart and Willard Allphin, Sylvania Electric Products, Inc., Salem, Mass.
Economics of Mercury Lighting for Industrial Areas — W. H. Johnson, W. H. Kahler, and D. W. Rowten, Westinghouse Electric Corp., Cleveland, Ohio.
Light and Color Engineering in Post Offices — Curtis E. Kautt and T. C. Cargill, Jr., Post Office Department, Washington, D. C.

Applications and Civilian Defense

Friday Morning — September 17

Vernon Room

Session Chairman: A. F. Wakefield, The F. W. Wakefield Brass Co.
Discussion Organizer: H. G. Clum, Silvray Lighting Inc.
Outdoor Decorative Lighting Techniques — R. A. Eshelby, Northern Electric Co., Montreal, Canada.
Symposium — Lighting for Civilian Defense — Barnet Beers, Assistant for Civil Defense, Office of the Secretary of Defense, Phillip Batson, Federal Civil Defense Administration, and J. C. Forbes, General Electric Co., Cleveland, Ohio.

Closing Business Session

12:30 P.M.

Vernon Room

Presiding Chairman: C. N. Laupp, Wisconsin Electric Power Co., Chairman, National Technical Conference Committee.
Report of the Resolutions Committee.

Northern California Repeats Successful Illumination Course

Oakland, San Francisco, and Fresno, California, are the sites for parallel sessions of a ten-week course in practical illumination, sponsored by the Northern California Section of I.E.S. The interest which this course has received in the past when conducted in some other areas in northern California has resulted in the formation of new I.E.S. Chapters there.

The combined visual and lecture course, with two-hour classes, includes sound slide films, motion pictures, slides of outstanding installations as well as demonstrations of light sources, control methods and basic principles. The speakers are all members of the Northern California Section. Outside reading and quiz questions for homework are assigned at each meeting, and practical problems are worked out at the last four sessions.

The Oakland meetings, held Tuesday evenings beginning October 5, take place at the auditorium of the Pacific Gas and Electric Co; those in San Francisco occur Wednesday evenings beginning October 6 at the Western Merchandise Mart; and the Fresno courses are Thursday evenings beginning October 7 in the Library of the Pacific Gas and Electric Co. offices there. The classes are held weekly on these days except for the week of November 22, and continue through the week of December 13. The program and speakers all three sets of sessions are:

Light and Sight—M. A. Cabot
Lighting Fundamentals—D. M. Finch
Light Control—R. G. Dummel
Fluorescent Lamps—Paul Schmidt
Incandescent Lamps—Chas. R. Long
Lighting Fixtures—John S. Walsh
Design—Fundamentals—R. E. Largerstrom
Design—Layouts—Robert Thailon
Office and School Lighting—C. W. Macy
Store Lighting—D. G. Parker

A total of 191 persons registered for the course: 57 in Oakland, 62 in San Francisco and 72 in Fresno. These include architects, consulting engineers, electrical contractors, office managers, and others in positions to bring about better lighting.

The program was arranged by the Section's Education Committee, John S. Walsh, Chairman and Milton C. Very, Vice-Chairman, with the cooperation of the I.E.S. members in the three areas. Tuition is $12 for the ten lectures, and copies of I.E.S. Recommended Practices, reprints of pertinent articles, and engineering and design data were supplied.

Gold Medal Nominations Due by January 1st

According to official I.E.S. Procedure, nominations for the I.E.S. Gold Medal Award for consideration by the 1954-1955 committee must be received at headquarters by January 1. The suggestion of any candidate can be made by sending his name to the Medal Award Committee at headquarters office, requesting consideration.

The complete Medal Award Procedure has been circulated to the Chairmen of all the Society's Sections and Chapters and may be secured from them, or from the Executive Secretary upon request.

Certificates Awarded for Lighting In Charlotte "Parade of Homes"

One of the highlights of the Charlotte, N. C., Parade of Homes, was the presentation of certificates of merit to eight builders and four electrical contractors for the lighting installations in eight of the twenty-one model homes on display. The homes were open to the public for the week of September 19 to 26, and an estimated 75,000 persons came to look at the latest in building, decoration, lighting and home equipment.

Early in the planning, the Carolinas Section (now Tar Heel Section) of I.E.S. realized the opportunity for the dissemination of sound lighting knowledge. A Residential Lighting Committee was formed: W. M. Kirkpatrick, General Electric Lamp Division, as Chairman; with James J. Cardo, Independent Electric Supply, and James M. Foreman, Duke Power Co. Copies of the recent I.E.S. publication "15 Home Lighting Ideas" were sent to 14 interior decorators and 35 residential archi-

(Continued on page 28A)

ATTENDANCE of 112 at the first meeting, September 23, of the St. Louis Section this year continues their tradition of well-attended sessions, with outside groups invited. Panel type discussion on "Lighting Horizons" featured P. Howard Farley of NECA; E. P. Schwalbach representing NAED and L. C. Messick for NEMA. Prior to the discussion, retiring Chairman George Herold was presented with a miniature gavel.

(*Continued from page* 27A)

tects; and builders were supplied with specifications for lighting equipment.

At the dinner meeting of the Section, honoring the builders and contractors, Dean Jenks, Home Builder Representative of the General Electric Lamp Department in Cleveland, was guest speaker, discussing developments in residence lighting and forecasting advances for the homes of the future.

New York Section, A.I.E.E., Gives Basic Illumination Course

A twelve-session course in illumination, "Good Lighting—What It Is and How To Get It," is currently being sponsored by the New Jersey Division of the New York Section of the American Institute of Electrical Engineers. This study group project, which is being held at the Public Service Electric and Gas Co., 80 Park Place, Newark, N. J., is featuring the following sessions:

October 5—What is Illumination—Prof. William Jordan III, Newark College of Engineering

October 18—Psychological and Physiological Aspects of Illumination—Prof. Stanley R. McCandless, Yale University and Century Lighting, Inc.

October 26—How to Get Good Illumination—Prof. Clyde C. Whipple, Brooklyn Polytechnic Institute

November 9—Lighting Fixture Design—K. A. Sawin, Wheeler Reflector Co.

November 16—Fluorescent Lighting Fixture Design—Charles L. Amick, General Electric Co.

November 23—Factors Affecting Design of Industrial Lighting Systems—Eric H. Church, Benjamin Electric Mfg. Co.

November 30—Design Considerations of Commercial Lighting Installations—George Taylor, Day-Brite Lighting Inc.

December 7—Decorative Lighting—S. W. Braun, Rambusch Decorating Co.

December 14—Outdoor Lighting—Gene G. Rae, Holophane Co., Inc.

December 21—Economics of Installation of Lighting Systems—James McKinnes, Watson-Flagg Engineering Corp.

January 4—The Economics of Lighting Systems—Bruce Jensen, Public Service Electric and Gas Co.

January 11—Maintaining Your Lighting System—T. C. Sargent, Sylvania Electric Products Inc.

Plastics in Building Topic for Two-Day Conference

A two-day conference with eight technical sessions was held October 27-28 at the National Academy of Sciences, Washington, D. C., with the purpose of better acquainting the building industry with the present status, future possibilities, and limitations, of plastic products for building. The meeting brought together architects, designers, engineers, contractors, builders, manufacturers of building parts, research men, chemists and plastics manufacturers. Experts from many fields allied with the building and plastics industries led the sessions and audience participation through question-and-answer periods followed each talk.

In one of the sessions directly concerned with plastics in lighting, I.E.S.'s Technical Director C. L. Crouch was moderator of the discussion period, which followed two talks: one on Light-Transmitting Panels, by John S. Berkson, President of the Alsynite Corp. of America; and the other on Glazing and Interior Illumination, by O. L. Pierson, of Rohm & Haas Co.

The meeting was conducted by the Building Research Institute, and was sponsored by the Manufacturing Chemists' Association, Inc., the Society of the Plastics Industry, Inc., and the Building Research Advisory Board.

History of Lighting Exhibit For Boston Jubilee Celebration

Light's Diamond Jubilee was celebrated by the New England Section of I.E.S. and the Electric Institute of Boston, Inc., by a Jubilee Dinner Meeting, October 21, featuring an exhibit of the history of lighting, held at the Museum of Science.

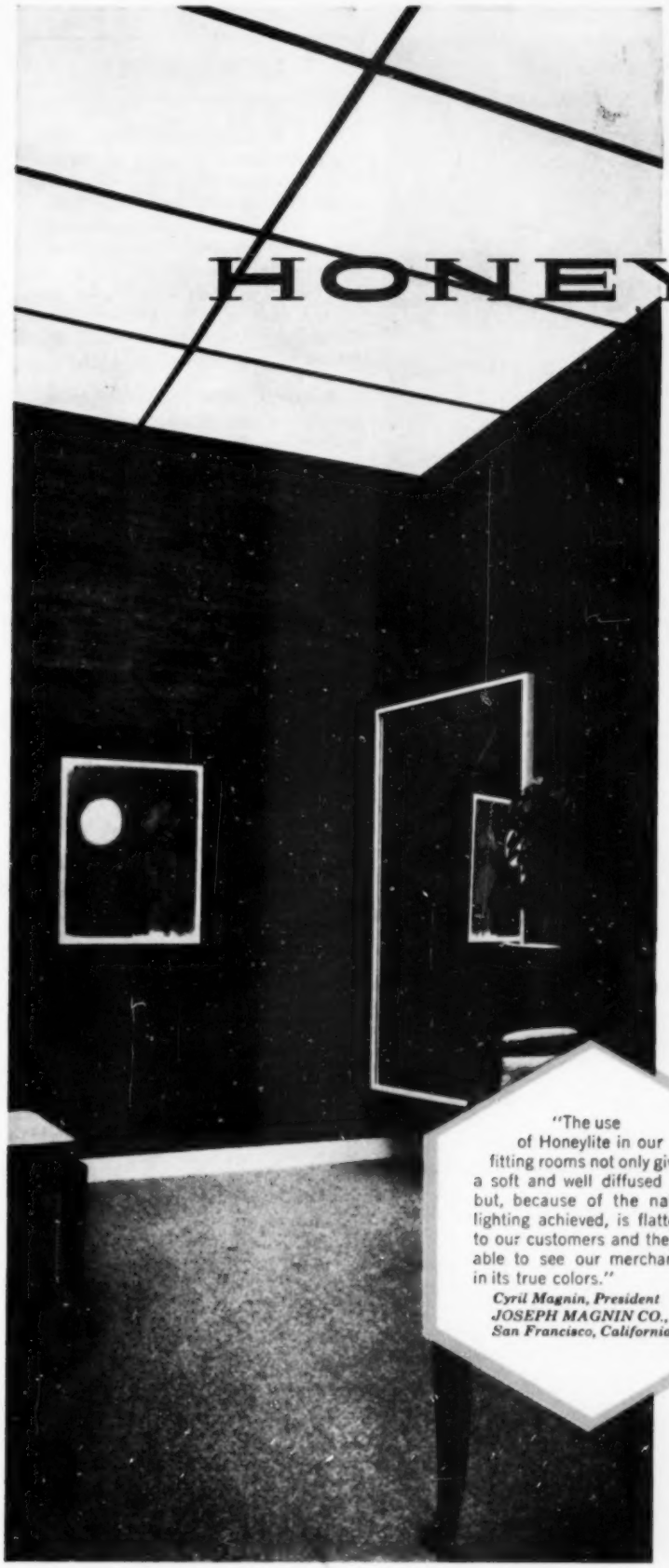
Featured speaker at the dinner was Julius Daniels, a Past President of the Illuminating Engineering Society, and Chairman of the Museum of Science Exhibit Committee. Mr. Daniels spoke on "The Story of Artificial Light." Also on the program were the President of the Electric Institute, Edward E. Martin of Graybar Electric Co.; Chairman of the New England Section of I.E.S., E. J. Perkins, of Holophane Co., Inc.; and Henry E. Russell, Vice-President of the Board of Trustees of the Museum of Science.

S. K. Guth Chief Speaker At Icelandic Society Founding

Dr. Sylvester K. Guth, head of Lighting Research for General Electric Lamp Division, Cleveland, attended the founding of the Icelandic Lighting Society, in Reykjavik, the capital of Iceland. As chief speaker on the two-week program, October 17 through October 29, Dr. Guth delivered four lectures: "Important Concepts of Light, Vision and Seeing," "How to Establish a Lighting Education and Demonstration Center," "The Value of an Illuminating Engineering Society to Architects, Medical Doctors, School Administrators and Others," and "Organization and Objectives of the International Commission on Illumination." Dr. Guth has been asked to assist in "seating" Iceland as an active member of the C.I.E.

Also highlighting the program, sponsored by the Samband Islenzkra Rafveitna (Association of Electrical Systems of Iceland) were group discussions on

(*Continued on page* 30A)



Specify the most beautiful ceiling in the world!

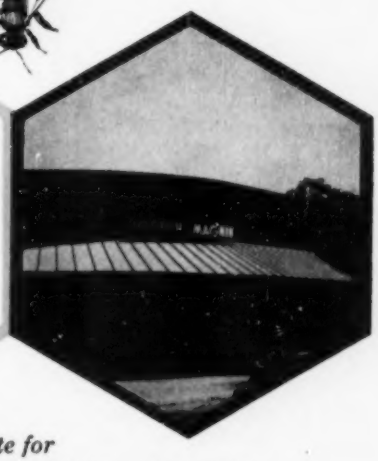
HONEYLITE

Now available for full ceiling and fixture unit lighting—**Honeylite** aluminum honeycomb is efficient, safe, strikingly beautiful! We believe its beauty must be seen to be fully appreciated—technically, the facts speak for themselves, presenting four big reasons for the use of light-diffusing **Honeylite** in office, store and factory:

1 **Honeylite** allows 95%-plus light transmission efficiency throughout lifetime of installation
2 **Honeylite** has highest light transmission to surface brightness ratio of any light-diffusing ceiling material...there is no reflected glare
3 **Honeylite** has a Noise Reduction Coefficient of .46, tested at same frequencies as acoustical ceiling materials
4 **Honeylite** allows free air circulation, increases lamp and ballast life up to 33-1/3%

"The use of Honeylite in our fitting rooms not only gives a soft and well diffused light but, because of the natural lighting achieved, is flattering to our customers and they are able to see our merchandise in its true colors."

Cyril Magnin, President
JOSEPH MAGNIN CO., INC.
San Francisco, California



Write for technical data and sample

HEXCEL PRODUCTS CO.

951 61ST STREET, OAKLAND 8, CALIFORNIA

OFFICERS and Committee Chairmen of the Southern California Section at the September 8 dinner meeting for the installation of officers. Left to right—seated: Roy Kreyser, Vice-Chairman; D. W. Prideaux, Past Chairman, now serving on Board of Managers; F. Edwin Blair, Chairman; and Leonard Hobbs, Past Regional V-P. Standing are Chairmen of the Section's committees and members of the Board of Managers—front row: S. I. Meyerson, Oscar Meissner, C. T. Gibbs, M. A. Potter, Ted Shepherd, B. J. Hartmann, Roy Bevan, H. R. Chilton, Roy Dahlin; rear row: Harold Strahn, R. L. Ford, D. R. Shields and J. J. Flora.

(Continued from page 28A)

specialized lighting subjects. Some 200 representatives of Icelandic electrical and technical organizations attended the conference.

Dr. Guth took with him a letter of greetings and congratulations to the new Icelandic Lighting Society from I.E.S. President Duncan M. Jones.

Adequate Wiring Stressed At N.E.C.A. Convention

"Guiding Industry Growth" was the theme of the 53rd Anniversary Convention of the National Electrical Contractors Association in New Orleans, October 27-30, with inadequate wiring one of the main considerations for discussion.

According to the organization's president, Don B. Clayton, of the 43 million homes now using electricity 25 million were built more than 30 years ago and their wiring is obsolete and needs immediate replacement for minimum safety and adequacy sake. No more than five per cent of the present homes are sufficiently wired for today's full use of electricity.

Mr. Clayton also reports that at least 90 per cent of commercial and industrial establishments are not sufficiently wired to produce at maximum capacity. Atomic development has required vast amounts of electricity and the prospect for atomic power generation promises even greater power use.

The convention, which had headquarters at the Jung Hotel, was the largest that N.E.C.A. has ever held, with over 2000 registered. Administrative meetings were held the week of October 20, and the general membership meetings began October 27.

Light's Jubilee Celebrated At Pan-American Union Building

More than 1200 attended the celebration of Light's Diamond Jubilee when the building and grounds of the Pan-American Union, one of Washington, D. C.'s loveliest buildings, were opened to the general public the evening of October 4. For the occasion, the white marble building and its wide lawn were specially lighted in commemoration of the anniversary.

A feature of the display was the outdoor lighting in many colors of the Aztec Garden, scene of many diplomatic parties, which is seldom opened to the public.

ABOUT PEOPLE

The E. F. Hauserman Company, Cleveland, Ohio, manufacturers of movable steel partitions, have retained **Darell Boyd Harmon** and Associates, Austin, Texas, as their educational consultants. Among the projects to be undertaken is a study of the educational design and application potentialities of the company's materials in both new school construction and rehabilitation of older school structures.

Walter D. Scott has been appointed manager of advertising and sales promotion for the Westinghouse Electric Corp. Lamp Division. Formerly assistant manager of the department, Mr. Scott succeeds **H. L. Niederauer**, who has joined the J. Walter Thompson advertising agency.

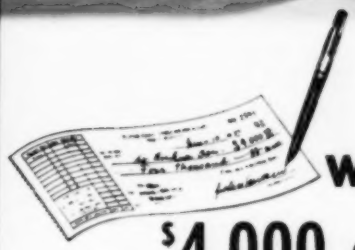
Maj. Gen. George Craig Stewart has been appointed general manager of the National Safety Council, a new post created to broaden top-level administration of the nonprofit accident prevention organization. He assumed his new duties early this month after his retirement from the Army October 31. He was formerly director of the Office of Military Assistance in the Office of the Secretary of Defense.

Sylvania Electric Products Inc., has announced some appointments in their Western Region. **Robert C. Harper** has been named Regional Sales Manager with his headquarters in San Francisco. **William L. Friend** has been transferred to Los Angeles as District Sales Manager, his position of District Sales Manager in San Francisco being filled by **Robert W. Thunen.**

Metalcraft Products Co., Inc., Philadelphia, have named **James A. Jennings** as sales representative in New York State, with headquarters at 471 Hamilton St., Albany. His territory includes the entire state with the exception of New York City.

Steber Manufacturing Co., Broadview Illinois, has announced the formation of a new company with manufacturing facilities on the West Coast. The new firm will operate under the name of Steber Manufacturing Co. of California, with a plant at 242 S. Anderson St., Los Angeles. **John Kresich** has been named sales manager and **Paul Waterbury** as special sales representative and lighting specialist. Both men are active members of the Southern California Section of I.E.S.

(Continued on page 31A)



would you turn down a savings of $4,000 on a $40,000 lighting expenditure?

You can enjoy the benefits of the *finest* lighting money can buy and effect really substantial savings at the same time, simply by buying the *right* lighting fixture. Time and again, the better design and efficiency of Smithcraft Fluorescent Fixtures result in *fewer units* to produce recommended lighting levels.

Here's an actual case history of how a Pennsylvania department store saved 10% in initial costs and 10% in operating costs . . . or approximately $4000 on a ten-year $40,000 expenditure.

Before re-lighting, a complete survey was made and exact lighting requirements were established. To meet these requirements, Smithcraft units and units of several nationally-known top quality manufacturers were subjected to an exhaustive *comparative* analysis. Here are the results:

10% *FEWER UNITS REQUIRED*

Number of units required to achieve recommended lighting levels: ..... Smithcraft — **270**
2nd Best Fixture — 297
3rd Best Fixture — 339

10% *LESS INSTALLATION COST*

Proportionately less labor and materials were required to install the 270 Smithcraft units than the 297 units of the nearest competitor.

10% *FEWER LAMPS*
(Initial & Replacement)

Lamps required: ..... Smithcraft — **706**
2nd Best Fixture — 776
3rd Best Fixture — 914

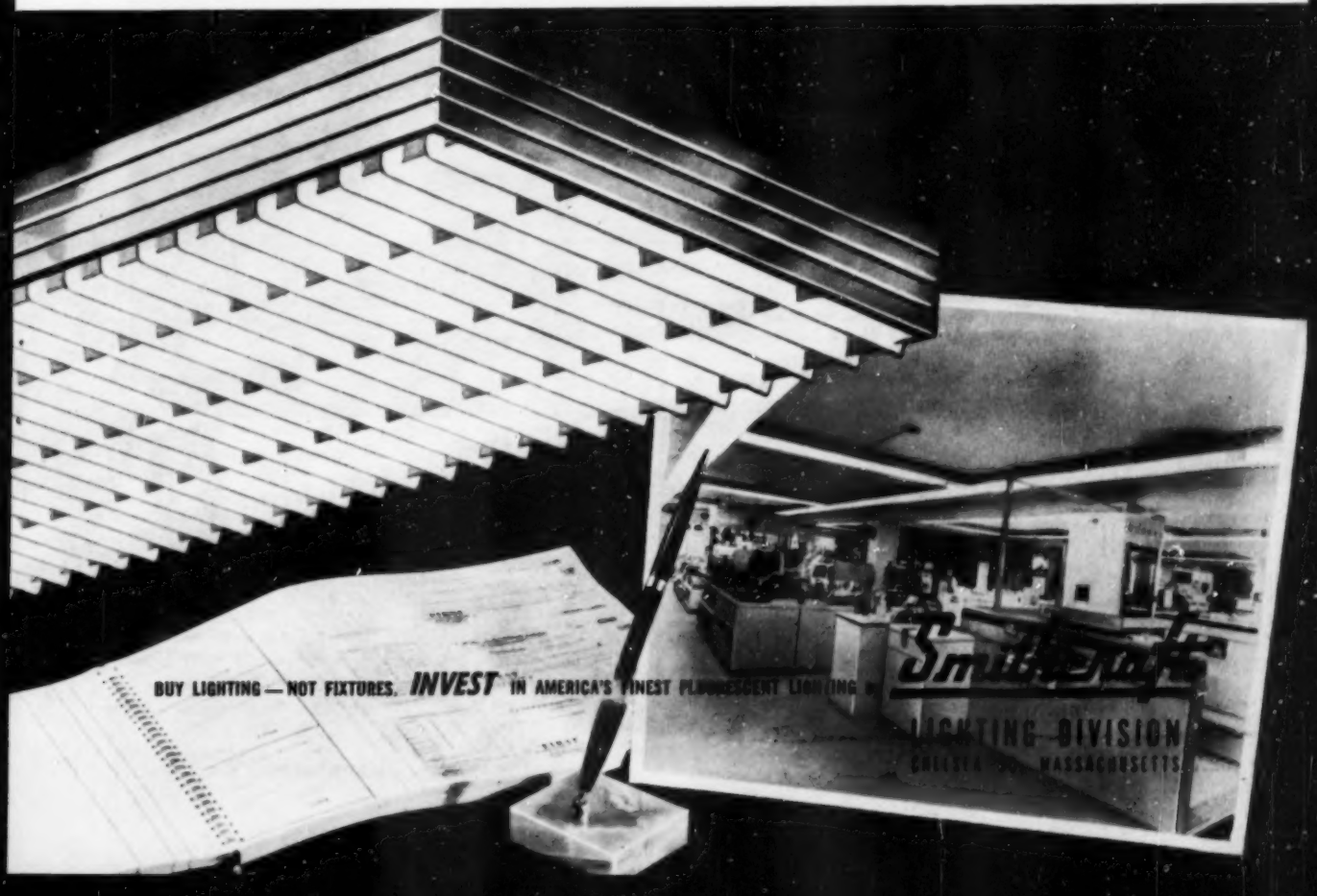
Recommended practice is to replace lamps every 18 months—a continuing 10% savings.

10% *LESS POWER CONSUMPTION*

Required wattage:..... Smithcraft: **51.3** kilowatts
2nd Best Fixture: 56.3 kilowatts
3rd Best Fixture: 64.8 kilowatts

Whether you're lighting a store, office, school, factory, or institution, it pays to *buy lighting — not fixtures.* Invest in Smithcraft — America's Finest Fluorescent Lighting Equipment.

PHOTOGRAPH SHOWS AN INTERESTING PATTERN ARRANGEMENT OF THE SMITHCRAFT LOUVERLITE SLIMLINE IN THE PENNA. DEPT. STORE DESCRIBED ABOVE.



COMPARE . . .

Exclusive on the Ortho-77 is the Uni-Race channel for automatic alignment, the Plug-in Socket for safe handling without disconnecting the circuit and unheard of flexibility, and the rugged V channel with integrated construction for permanence of shape.

	Ortho-77	Conventional
OVERALL COST	Reports show savings up to 50% in installation costs with the Ortho-77, which means that you can buy the Ortho-77 *installed* for the same price as ordinary fluorescent fixtures.	Installation costs of ordinary fluorescent fixtures average nearly *twice* that of comparable Ortho-77 installations. Although initial costs are in some instances lower, the overall installed cost of the Ortho-77 is favorable.
INSTALLATION	Uni-race sections can precede fixtures to the job. Easily and quickly mounted, they assure positive, permanent straight alignment automatically. Fixtures may be shipped when the building is ready for occupancy and can be hung without tools in minimum time.	In conventional installations, heavy fixtures often must be handled many times on the job. Permanent alignment is frequently difficult to maintain without accessories. Because of the tools and handling necessary, it is difficult to keep fixtures clean in mounting.
FLEXIBILITY	Fixtures of same wattages are interchangeable on the same Uni-Race. Lighting levels can be raised from two to four lite in a matter of minutes, or fixtures can be mounted at spaced intervals and made continuous anytime later without tools in a minimum of time.	Conventional fixtures offer virtually no flexibility in so far as fixture interchange or change of lighting layout is concerned.
MAINTENANCE	Ballast replacement can be made in a matter of minutes by changing fixtures instead of parts. Repairs can be made in the shop at will and service on the line will not be interrupted *even while changing fixtures.*	With conventional fixtures, it is necessary to suspend service on the entire circuit to make repairs. Frequently the working area is disrupted for several hours while this is being accomplished.

WRITE TODAY for descriptive folder giving details of the Ortho-77

HUBBARD Manufacturing Co.

1919 PIEDMONT CIRCLE, N.E.

ATLANTA, GEORGIA

(*Continued from page* 30A)

Ralph A. Yates, vice-president and general manager of Wakefield Lighting Limited, London, Ont., was elected Chairman of the Interior Lighting Section of the Canadian Electrical Manufacturers Association at its tenth annual meeting at Niagara Falls, Ont., in September.

Daniel Rashall has been promoted to the position of National Sales Coordinator for Sunbeam Lighting Co., Los Angeles. Mr. Rashall had joined Sunbeam last June as sales promotion and public relations director, and was formerly managing director of the Western Lighting Manufacturers Institute.

James C. Brock and **James G. Fortney** have been appointed agent for the Lamp Division of Westinghouse Electric Corp., with a sales territory including northern Alabama, northeastern Mississippi and southern Tennessee. Headquarters are in Florence, Ala.

Two new District Sales Supervisors have been appointed recently by the Lighting Division of Sylvania Electric Products Inc. **John J. Bahnak** has been named to the Minnesota territory and will have his office in the Plymouth Building in Minneapolis. He was formerly a sales representative for the company. **Donald M. Cainfield** has been promoted to Supervisor in the Cleveland area and will make his headquarters at the company's new warehouse and sales office at 4848 West 130th St., Cleveland.

INCOMING officers of the British Columbia Section study the Section's Charter. From left to right, they are: J. Gilbreath, Vice-Chairman; T. H. Doherty, Chairman; and N. Kolbeins, Secretary.

IT SEEMS TO ME

Modular Coordination

I have read Mr. Wakefield's article in ILLUMINATING ENGINEERING (April 1954) concerning "Modular Coordination" and the subsequent coments with considerable interest because for some time I have wanted to do something about it with our Public Buildings Service standard recessed fixtures, but pressure of work has delayed action on it. When I read his remarks to the effect that lighting fixture manufacturers have been unsuccessful in accomplishing it (which is quite true), I decided, because of its importance, to do something about it right away.

As the lighting industry knows, the Public Building Service's standard suspended types of fluorescent lighting fixtures have always been made up on the even dimensions, strictly in line with the principles of modular coordination, but the recessed types have been ⅛ inch over on each basic unit, so that in a multiple unit installation, this ⅛ inch keeps adding up, and does not work out so well architecturally, especially when they are installed in a 12-inch or other tile ceilings that are in line with the module principle.

To overcome this undesirable feature, the Public Buildings Service's recessed fluorescent fixtures have been revised and by making the troffer an open end trough, except for a narrow cross supporting piece on the open bottom at each end of each basic unit where it does not interfere with the lampholders and by adding a very simple end piece and a joining piece, the length of basic units is now the same as the nominal lamp lengths over lampholders, *i.e.*, 24, 36, 48 inches, etc.

The frames will make a ⅝-inch overlap over the adjoining tile, which will evenly cover the mitered edge of the tile at sides and ends of the fixture, whether it is a singly installed unit or two or more units installed end to end to form a continuous multiple unit fixture. Where the end plate adds the thickness of the plate at the extreme ends of complete fixtures, that slight additional length over the even dimension occurs above the ceiling construction, so it does not affect fitting within the tile dimensions, nor does it prevent planning on the four-inch module basis.

The details of these standard recessed fixtures of types having diffusing panels and louvered bottoms are shown on Public Buildings Service's Standard Detail Drawings No. 10-9-8C and 10-0-16C.

I am writing with the purpose of giving modular coordination a further boost and also with the hope that it may be of some value to the lighting industry, since Public Buildings Service standard designs are not restricted by patents and are available for use by any who may wish to take advantage of them. THOMAS F. COGHLAN, *Electrical Engineer, Public Buildings Service, Central Office, Washington 25, D. C.*

Inadequate Wiring

The Oregon Section of the Illuminating Engineering Society wishes to present the following official protest at allowing a photograph to set a bad example for adequate wiring.

This photograph is shown on page 333 of the July 1954 issue of ILLUMINATING ENGINEERING, incorporated in the article of Mr. G. Allison Long, Jr., entitled "Lighting the Small Amateur Stage." Figure 2 is the photograph questioned.

We, of the Oregon Section, feel that our publications, more than just a guide to proper lighting, should also uphold the standards of adequate wiring. This photograph certainly is of the type that is normally used in a "before" picture of a "before and after" sequence.

Regardless of the fact that the author carefully states that the total load must not exceed 600 watts in this type of installation there is no means of preventing the stage hands for continuously building up this "Christmas tree" to beyond this limit and causing serious trouble. The mere fact that these cube taps are used would indicate that they

(*Continued on page* 34A)

(Continued from page 33A)

are advised whenever additional "plug-in" capacity is needed.

We realize that the statements in the contributions to this magazine are not necessarily the opinions of the Society, but we do feel that some control should be exercised to forbid the recommendation of such flagrant examples. DUDLEY D. MOORE, *Secretary-Treasurer, Oregon Section, I.E.S.*

NEW MEMBERS

At the meeting of the I.E.S. Council held in New York, October 14, 1954, the following were elected to membership. Names marked ° are transfers from Associate Member grades.

ALAMO CHAPTER

Associate Members:
Sweeney, G. F., Local Union #60, International Brotherhood of Electrical Workers, San Antonio, Texas.
Telotte, T. C. Jr., Telotte Electric Co., San Antonio, Texas.

ARIZONA CHAPTER

Associate Members:
Hollins, C. K., Old Pueblo Broadcasting Co., Tucson, Ariz.
Pickrell, C. U., Jr., Arizona Public Service Co., Phoenix, Ariz.

ARKANSAS CHAPTER

Member:
Rowe, S. H., Blaylock & Associates Inc., Little Rock, Ark.
Associate Member:
Clark, K. G., O'Bannon Bros., Little Rock, Ark.

BRITISH COLUMBIA SECTION

Associate Members:
Damon, R., Associated Consulting Engineers, Vancouver, B. C.
Hilder, Lewis, Hi-Test Sales & Service, Vancouver, B. C.

CAPITAL SECTION

Associate Member:
Pole, R. F., Potomac Electric Power Co., Washington, D. C.

CENTRAL ILLINOIS CHAPTER

Associate Member:
Maddock, J. G., Associated Engineers, Peoria, Ill.

CENTRAL NEW YORK SECTION

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DeWald, L. E., Marvin Mfg. Co., Syracuse, N. Y.
Ittenbach, Mrs. Shirley R., 1728 Slaterville Rd., Ithaca, N. Y.
Taft, Miss Kathleen I., Corning Glass Works, Corning, N. Y.

CHICAGO SECTION

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Pendleton, Mark, Jr., Joslyn Mfg. & Supply Co., Chicago, Ill.
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Sanders, Kerr, Jr., Chicago Lighting Institute, Chicago, Ill.
Trullson, Neal, General Electric Co., Chicago, Ill.

CLEVELAND SECTION

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Ewing, T. J., General Electric Supply Co., Youngstown, Ohio.
Messinger, C. T., General Electric Co., Cleveland, Ohio.
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Phillips, O. A., Case Institute of Technology, Cleveland, Ohio.

CONNECTICUT SECTION

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Sugrue, M. R., The Connecticut Light & Power Co, Willimantic, Conn.

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°Bates, Ford, Omaha Public Power District, Omaha, Nebr.
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Berget, E. A., Line Material Co., Milwaukee, Wis.

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EASTERN PENNSYLVANIA SECTION

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Edwards, H. R., Hughes Supply Inc., Daytona Beach, Fla.
Logan, G. C., Tampa Electric Co., Tampa, Fla.
Priday, G. L., Raybro Electric Supplies Inc., St. Petersburg, Fla.
Savarese, J. A. Jr., Tampa Electric Co., Tampa, Fla.
Stallings, B. T., Box 3273, Tampa, Fla.

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°Luber, Otto, Siemens Schuckertwerke A.G. 16 Kruppstrasse, Essen, Ruhr, Germany.
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Ferreira, C. A., Philips del Uruguay S.A., Uruguay 118, Montevideo, Uruguay.
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Matsuda, Chozaburo, Electrical Engineering Institute, Kyoto University, Kyoto, Japan.
Purdie, H. A., 61 King St., Prahan S. I., Melbourne, Victoria, Australia.
Stammbach, R. B., Esta Ltg. Research & Elec'l Appliances, 56 Elisabethenstrasse, Basle, Switzerland.
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Rayworth, R., Rayworth Electrical Service, Amherst, N. S.

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de Zamacona, Luis, Installaciones Electricas-Iluminacion, Av. Melchor Ocampo No. 363, Mexico, D.F.
Tajonar, A., "Eureka" Rotulos Neon, s.deR. L. de C.V., Ap. Postal 20646, Mexico, D.F.
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Farquhar, R. L., Westinghouse Electric Corp., Dayton, Ohio.
Hart, E. A., Hart-Igleburger & Associates, Dayton, Ohio.
Lakatos, Paul, John A. Becker Co., Dayton, Ohio.
Wannemacher, Howard, Mutual Electric Co., Dayton, Ohio.
Watt, E. M., Dayton Power & Light Co., Dayton, Ohio.
Williams, J. F., Dayton Power & Light Co., Dayton, Ohio.

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Tamm, N. A., Light & Power Utilities Corp., Memphis, Tenn.

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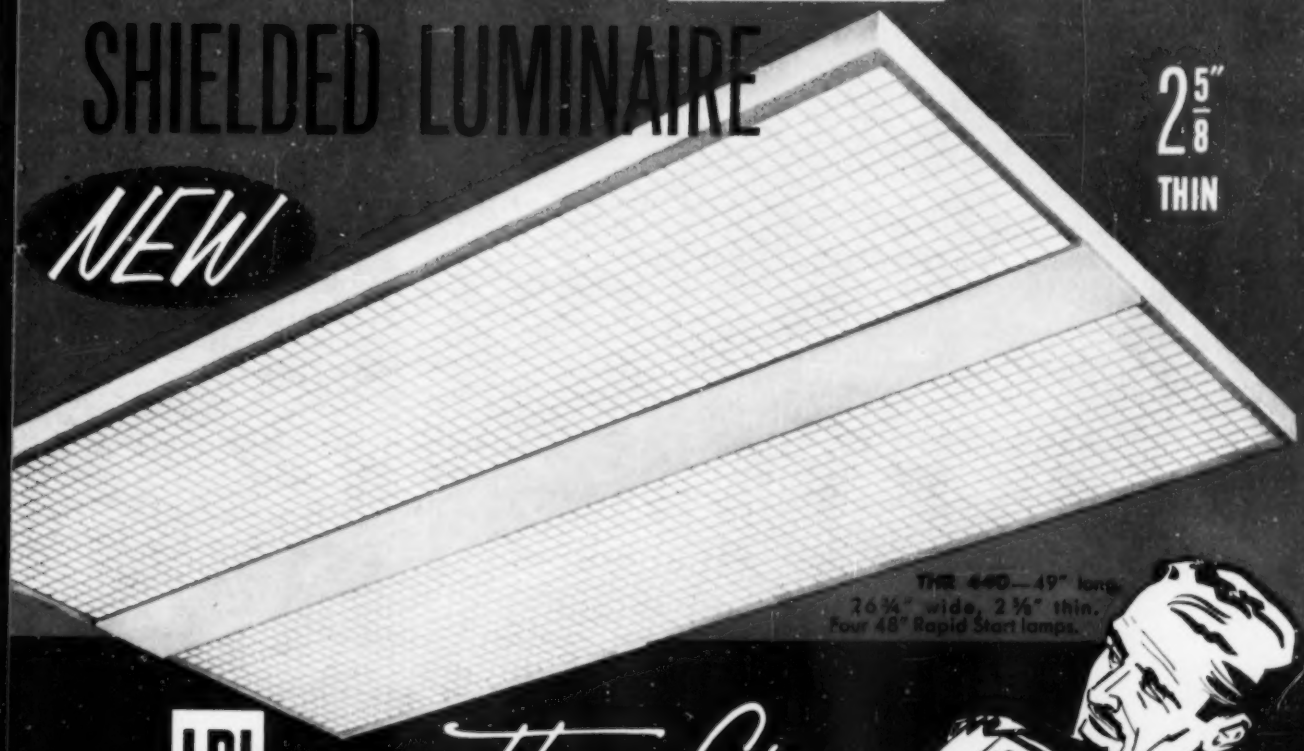
(Continued on page 36A)

NOT JUST *THIN*...NOT JUST *THINNER*... BUT THE WORLD'S *THINNEST* SHIELDED LUMINAIRE

NEW

2 5/8" THIN

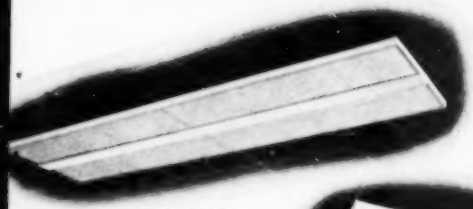


THR 440—49" long, 26¾" wide, 2⅝" thin. Four 48" Rapid Start lamps.

LPI *Thin-Lite*

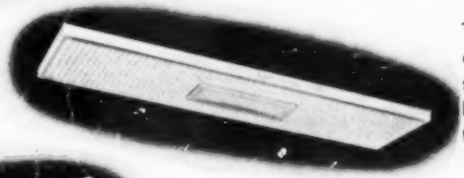
THS 496

97" long, 26¾" wide, 2⅝" thin. Four 96" 430 MA. lamps.



THR 240

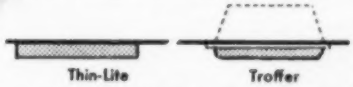
49" long, 12¼" wide, 2⅝" thin. Two 48" Rapid Start lamps.



THS 296

97" long, 12¼" wide, 2⅝" thin. Two 96" 430 MA. lamps.

The fundamental concept behind the Thin-Lite series is the creation of a semi-recessed effect by means of an extremely shallow surface mounted fixture (an unbelievable 2⅝" thin). Imagine—the depth below ceiling is essentially the same as troffers fitted with dished shields.



Thin-Lite luminaires can be mounted end to end or side by side to form any desired lighting pattern. From every viewpoint—appearance, economy, ease of installation and maintenance—Thin-Lite by LPI is a born leader.

Write for Complete Details

5368

LIGHTING PRODUCTS INC., Dept. 6B, HIGHLAND PARK, ILLINOIS

(Continued from page 34A)

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Olsen, A. M., Panama Lamp & Commercial Co. Inc., Los Angeles, Calif.
Temple, R. B., General Delivery, Fallbrook, Calif.
Wilde, L. E., Sylvania Electric Products Inc., Los Angeles, Calif.
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Ripley, N. N., General Electric Supply Co., Charlotte, N. C.
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*Ridley, W. H., Nashville Electric Service, Nashville, Tenn.
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Rehpohl, W. L., Walter Butler Co., St. Paul, Minn.
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Meredith, A. B. Jr., Westinghouse Electric Corp., Buffalo, N. Y.
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Zeller, H. O., 56 W. Terrace, Lakewood, N. Y.

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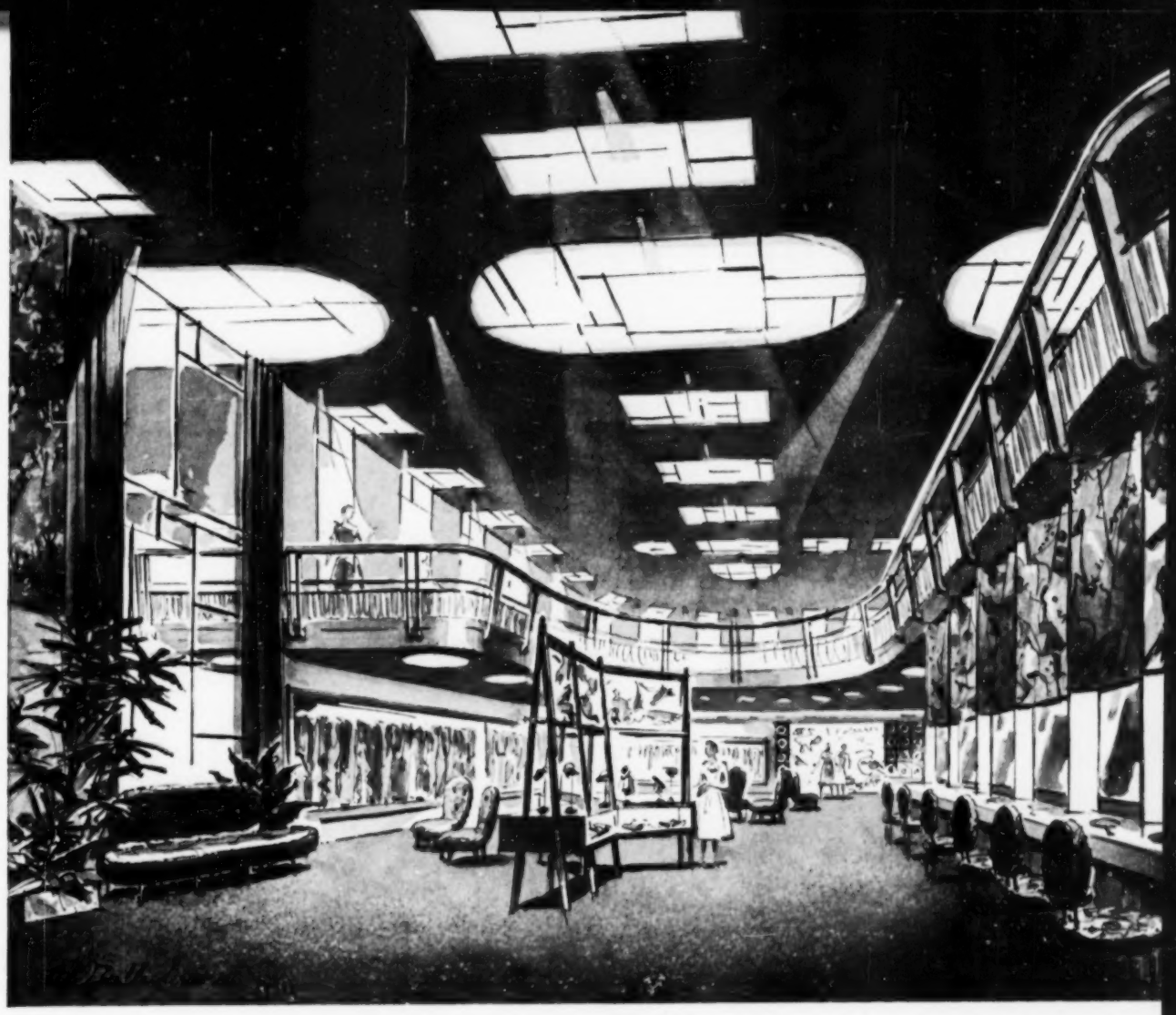
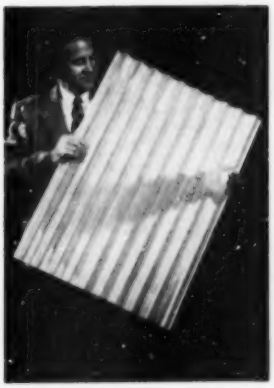
Associate Member:
Haney, N. L., Bunston Ltd., Winnipeg, Man.



Highlighting high fashion

Many dramatic lighting effects achieved with extruded Du Pont LUCITE® acrylic resin

A luminous panel of "Lucite" transmits light without glare because of its excellent diffusing power. Clear and translucent colors are available.



Corrugated panel of "Lucite" for light-diffusing ceilings. "Lucite" has excellent impact strength and color stability, and is easy to clean.

Architects and lighting engineers have a free hand to design unusual lighting arrangements with Du Pont "Lucite." Extruded "Lucite" is now available for troffer-type units and light-diffusing ceilings in flat, shaped and corrugated panels. Extruded sheeting can be shaped to satisfy the designer's needs.

"Lucite" transmits optimum light yet eliminates glare. It has excellent impact strength and maintains its original color as required by modern indoor lighting. Clear and translucent white "Lucite" is stable in direct outdoor sunlight and resists weathering, which makes "Lucite" an ideal material for outdoor lighting fixtures and skylights. Fabrication is economical. A variety of clear, translucent, and opaque colors is available.

Write to E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 2811, Du Pont Building, Wilmington 98, Delaware, for further information on this beautiful, durable engineering material.

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

SYLVANIA ANNOUNCES

THE NEW SUPER DELUXE FLUORESCENT LAMP

Makes Merchandise Look More Colorful and Attractive

Sylvania's new Super Deluxe fluorescent lamps are the answer to your problem of showing merchandise at its most colorful best. These new lamps give the best overall rendition of color yet achieved by fluorescent lamps, not only improving the appearance of the merchandise being displayed, but also giving a more flattering appearance to customers and sales people.

This new lighting tool can mean dollars and cents to all sellers of goods to whom attractive appearance of merchandise means more sales.

For full details on this new Super Deluxe fluorescent lamp, write for Booklet FI-532, Sylvania Electric Products Inc., Dept. 4L-3511, 1100 Main St., Buffalo 9, N. Y.

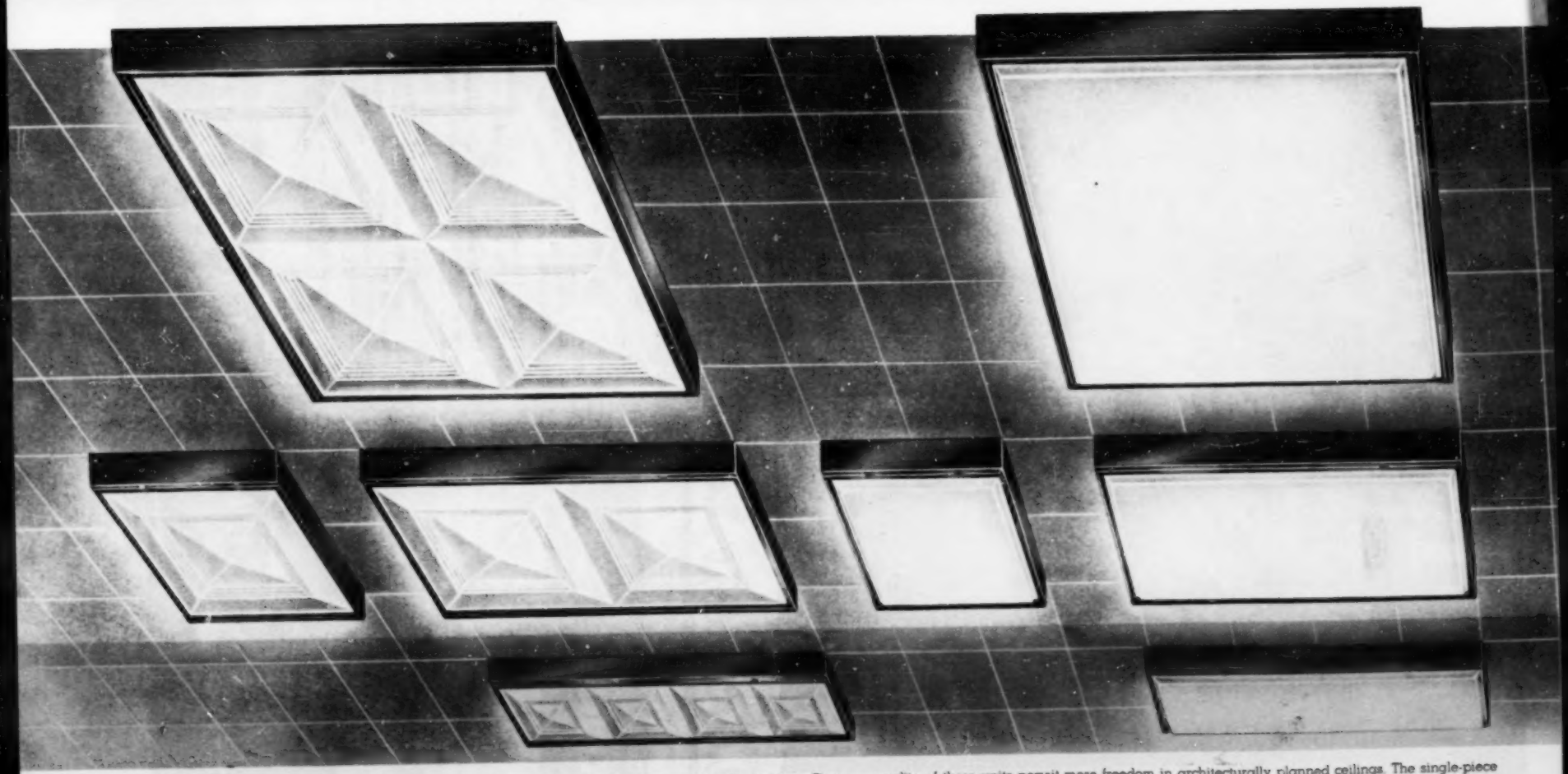
LIGHTING FOR **COLOR** IS LIGHTING FOR **SALES!**

SYLVANIA

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

Lighting · Radio · Electronics · Television

WHAT'S YOUR CHOICE?



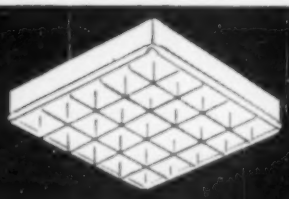
We know that your choice depends, first and foremost, on *quality lighting*. That is why Sunbeam Lighting fixtures are constantly engineered for greater quality. Knowing that your choice also depends on a choice, Sunbeam Lighting offers an extensive selection of modern, commercial luminaires each designed to do a specific lighting job. Now you may wish to choose Sunbeam's new, "large area," Plexiglas shielded, surface-mounted units for soft, low brightness, efficient illumination in stores, offices, banks and other commercial areas. The modular quality of these units permit more freedom in architecturally planned ceilings. The single-piece diffusers are molded from translucent white Plexiglas and assure long-lasting lighting efficiency. You have a choice of either smooth, "dropped" panels or geometrically designed panels for textural effects. Shallow in appearance, these new units are finished in standard white enamel which blends with most ceilings.

4 x 4 feet are #4800, 2 x 4 feet are #4600, 1 x 4 feet are #6600.

Let us know what your choice is and we will gladly send more information.

SUNBEAM LIGHTING COMPANY, 777 EAST 14TH PLACE, LOS ANGELES 21, CALIFORNIA

Only - Luve·tile



can do the job so well . . .

When it comes to Low brightness, large area light sources . . .

because . . .

LUVE-TILE in the long run is the most economical illuminated ceiling you can buy.

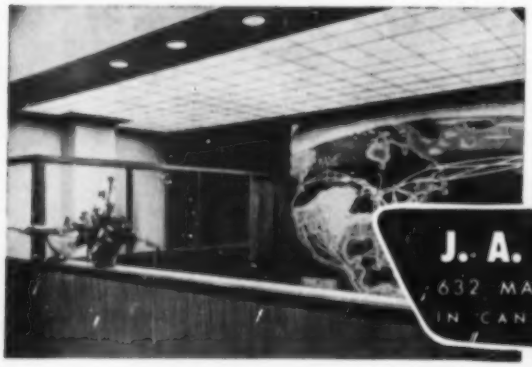
LUVE-TILE is easy to maintain—dirt collection is much less rapid than with other types . . . and it will not hold insects and other small matter.

LUVE-TILE is hinged, servicing of fixtures is easy. Rigid to handle, and light in weight, it is simple to remove and wash.

LUVE-TILE may be assembled to suit any room and custom-made work is never necessary. No unsightly horizontal bars or rosettes are used for support.

LUVE-TILE comes in 4 shades making possible unlimited colour combinations. Sprinklers and air ducts are concealed and wiring and other work may be simply surface mounted. Also low cost acoustic material may be sprayed on the cavity above the tile for sound proofing.

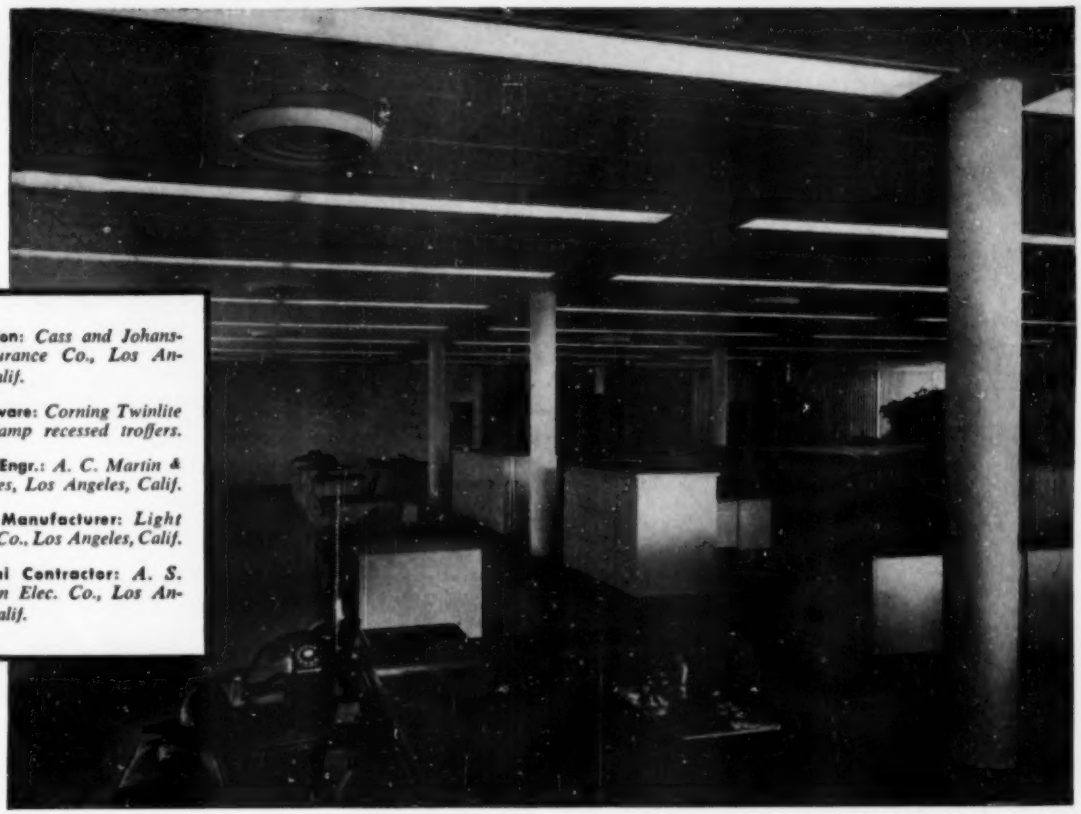
LUVE-TILE is practical and economical to use in any area, right down to a few square feet. It is also widely used in display for special effects.



J. A. WILSON LIGHTING & DISPLAY LTD.

632 MAIN STREET, BUFFALO 2, N.Y., PHONE MOhawk 5596

IN CANADA 280 LAKESHORE ROAD, TORONTO, ONTARIO



Installation: *Cass and Johansing Insurance Co., Los Angeles, Calif.*

Lightingware: *Corning Twinlite in two-lamp recessed troffers.*

Arch. & Engr.: *A. C. Martin & Associates, Los Angeles, Calif.*

Fixture Manufacturer: *Light Control Co., Los Angeles, Calif.*

Electrical Contractor: *A. S. Schulman Elec. Co., Los Angeles, Calif.*

The illumination achieved in this engineered lighting assignment is approximately 55-foot candles.

Insurance firm solves two lighting problems at once

Just think—combining beauty and high lighting efficiency used to be one of your toughest problems. Now—it's one of your easiest!

This insurance office is a case in point. Requirements called for high illumination – necessary to facilitate comfortable reading of detailed information—and functional beauty to match a modern office.

In this case, CORNING Twinlite panels provided efficiency with beauty. A prismatic fluorescent lightingware made of water-white crystal glasses, CORNING Twinlite panels give controlled brightness with true color transmission.

Prisms accurately direct light to working areas and they keep glare from critical zones. Twinlite panels have a special configuration on their back surfaces. CORNING Twinlite is excellent for use in banks, stores and restaurants. You can order Twinlite in flat and curved panels in a standard width of 11 inches and a standard length of 50 inches. And you can use Twinlite with low ceilings or high. Your clients will endorse your selection of Twinlite for its beauty, its efficiency—and for its easy cleaning.

You can call on Corning to help you simplify many lighting problems. Corning makes lightingware for prismatic fluorescent, diffusing fluorescent, louvering fluorescent and prismatic incandescent applications. "Architects and Engineers Handbook of Lighting Glassware" gives you the facts on all of them.

You'll find this handbook helpful in estimating lighting requirements and in writing specifications, too. It suggests lighting plans to help you even further. Let us send you a free copy. Mail the coupon today.

CORNING GLASS WORKS
CORNING, N. Y.

Corning means research in Glass

CORNING GLASS WORKS, Dept. IE-11, Corning, N. Y.

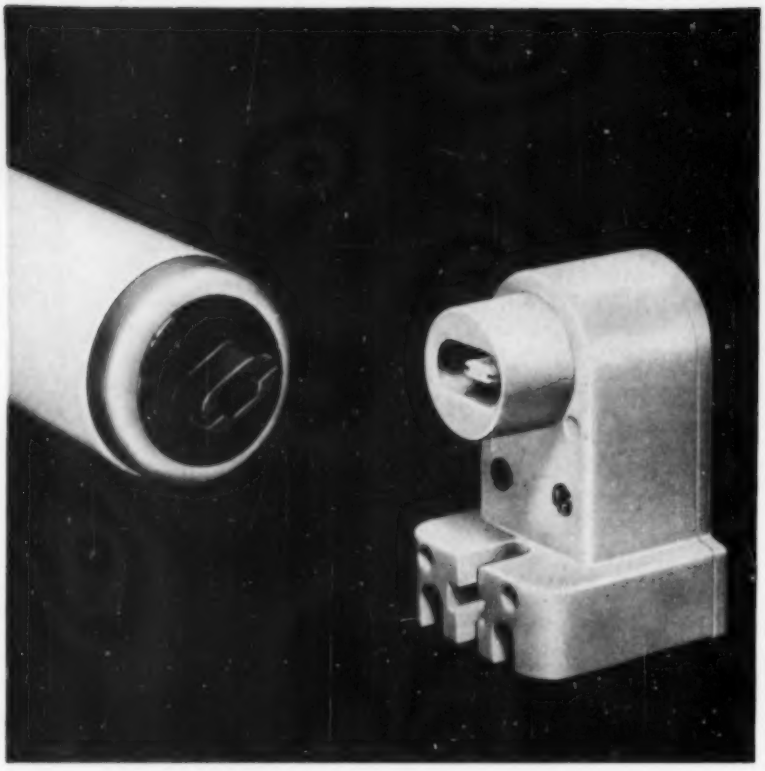
Please send me a copy of the "Architects and Engineers Handbook of Lighting Glassware," LS-43.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....



G-E companion lampholders announced for use with General Electric's new high-output rapid-start lamp

Telescopic Action Makes Lamp Insertion Easy

General Electric's Accessory Equipment Department offers new lampholders designed specifically for use with the new G-E 96T12 high-output rapid-start fluorescent lamp. The design of the new lampholders provides flush mounting against the lamp base and positive interlocking with the recessed contacts in the lamp base. Telescopic action built into the new lampholder makes lamp changing a simple operation . . . keeps lamps locked safely in position. In addition to the above features the new lampholders contain silver-plated contacts that provide double-wiping action.

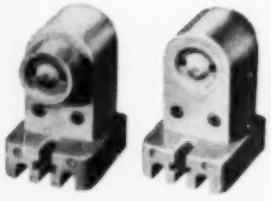
For complete information on these and other G-E lampholders, write to Section Q70-1187, General Electric Company, Bridgeport 2, Connecticut.

Progress Is Our Most Important Product

GENERAL ELECTRIC

OTHER G-E FLUORESCENT LAMPHOLDERS

Medium bi-pin disconnect type: For use with single, T12 rapid-start lamps. Rated 600 volts—660 watts.



Rapid start bi-pin telescopic type: For use with all T8 and T12 bi-pin lamps. Rated 600 volts—660 watts.

Heavy-duty standard medium bi-pin butt-on type: For T8 and T12 lamps. Rated 600 volts—660 watts.

Turret* lampholder: Spring-backed contact plates anchor lamps securely and eliminate lamp safety guards. Available for two- and three-lamp standard, rapid start, and instant start, and bi-pin fixtures, as well as slimline types.

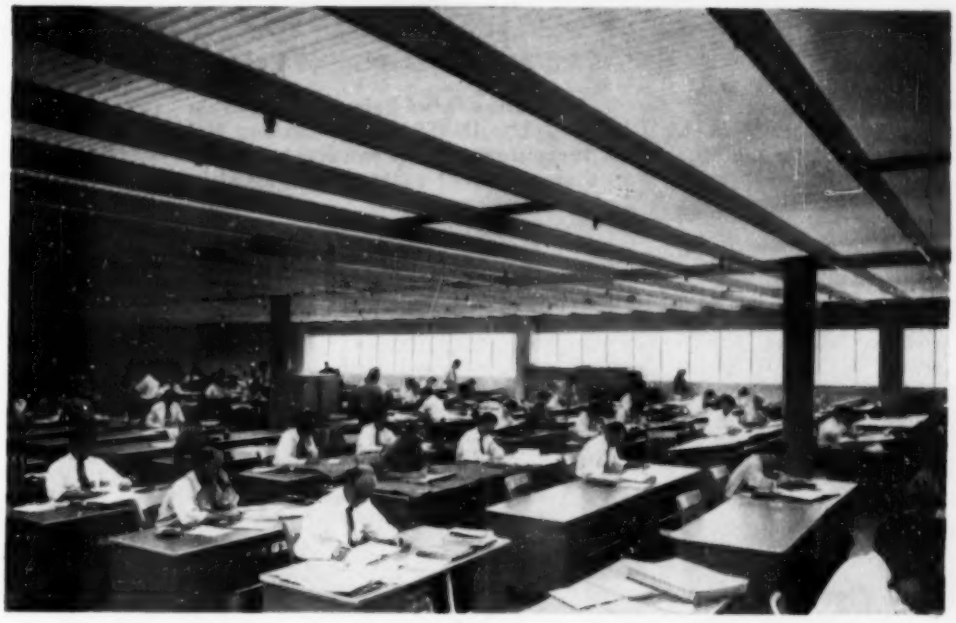
**Registered Trade-mark General Electric Company*

ACCESSORY EQUIPMENT DEPARTMENT

Manufacturers of wiring components for lighting • appliances and equipment power supply cords • wiring harnesses

A department of General Electric's Construction Materials Division, Bridgeport, Connecticut

Unprecedented Multi-Function Wakefield Ceiling Installed in New Douglas Aircraft Design Center



Aircraft Design Building
El Segundo Division of Douglas Aircraft

Architects and Engineers: Kistner, Wright and Wright Los Angeles

Licensed Agent:
Graybar Electric Company, Inc. Long Beach, Calif.

Wakefield luminous ceiling covers 2 acres and integrates acoustical baffles, air diffusers, sprinkler heads and other basic electrical services.

Called the world's most advanced aircraft design building, the new Douglas two-story Design Center in El Segundo, California, houses a 1500-man engineering team in an environment as nearly perfectly conducive to human efficiency as can be conceived. Not only is the illumination, which averages 90 to 100 footcandles, exceptionally comfortable but in addition the wall-to-wall electric ceiling, designed and built by Wakefield, incorporates services such as sound control, air diffusion, fire protection, power outlets, inter-communication and telephone systems.

LIGHTING DATA

Maximum brightness of diffusers 150 footlamberts, with F-96T12 slimline standard white lamps spaced 36 inches on centers and located 24 inches above plastic diffusers.

6 inch deep acoustical baffles, also spaced 36 inches on centers, provide excellent shielding.

Maximum brightness of baffles between 50 and 60 footlamberts.

Light wall colors and finishes combine with high intensity low brightness lighting to create comfortable environment.

Windows glazed with tinted glass. South windows have solar-controlled vertically louvered aluminum shields outside.

Wakefield is proud to have been chosen to work with the management of Douglas Aircraft and their architects and engineers in the planning and building of this impressive new design center. A number of new brochures on the Wakefield Ceiling and Wakefield Geometrics, designed particularly for illuminating engineers and architects, have recently come off the press. Write to The F. W. Wakefield Brass Company, Vermilion, Ohio. In Canada: Wakefield Lighting Limited, London, Ontario.

Wakefield Over-ALL Lighting

NEW EQUIPMENT DATA
AVAILABLE WITH COUPON

New manufacturers' catalogs and bulletins listed below are available free to readers of ILLUMINATING ENGINEERING by mailing the coupon. Circle the numbers of those items which you want, drop in envelope or fasten securely to back of 2-cent postcard addressed to Publications Office.

1 STYRON 647, new light stable polystyrene plastic, is described in new 12-page booklet of the same name. Information includes properties, fabrication considerations, finishing and suggested uses. Dow Chemical Company, Midland, Mich.

2 "Your Store" is title of folder-booklet covering company's complete line of commercial fluorescent fixtures, including technical data on each. Pages show suggested uses in various types of retail establishments; tell advantages and benefits of improved store lighting. Miller Co., Meriden, Conn.

3 "Fluorescent Guide," 22-page, 2-color booklet, is written in non-technical language for use of buyers and sellers of fluorescent products, and contains information on nature of fluorescent lighting; advantages; available lamp sizes, colors, and accessories. Sylvania Electric Products, Salem, Mass.

4 Specification sheet No. FL-199 contains revised dimensional diagrams of new lower and lighter rapid start ballast along with electrical specifications, wiring diagram and ballast features. Sola Electric Co., Chicago, Ill.

5 Eleven new specification pages for several of this company's line of fluorescent fixtures, an "Exit" sign and a surface mounted accent unit, have just been published. Pages are conveniently punched for binder and contain complete engineering data and installation details. Day-Brite Lighting, Inc., St. Louis, Mo.

6 New acrylic dome skylight is described in 4-page, 2-color folder, giving advantages and installation details on this type of down-lighting with daylight. Cross section diagram and schedule of stock sizes and specifications are included. Architectural Plastics, Inc., E. Norwalk, Conn.

7 "Chalkboarder" is title of 4-page, 2-color folder giving details of new fluorescent lighting fixture of same name designed for supplementary lighting of vertical surfaces such as classroom chalkboards, libraries, art galleries, and elsewhere. Smithcraft Lighting Division, Chelsea, Mass.

8 Bulletin FF-3 is complete, informative catalogue on UNISTRUT channel and fittings for wiring lighting installations and supplementary power wiring for machines, hand tools, motors, etc. States advantages and details of UL approval. Unistrut Products Co., Chicago, Ill.

9 "Lighting . . . by Safety," Bulletin 4664, describes company's new line of commercial fluorescent units in square and rectangular shapes, each a multiple of 12" ceiling blocks. Construction details, finish, etc., are described. Safety Car Heating and Lighting Co., New Haven, Conn.

10 LUMATROL omnidirectional photoelectric light switch is covered in 4-page, 2-color folder telling of new circuit principle involved and giving advantages and specifications. Micro Balancing, Inc., Garden City Park, N. Y.

11 18-page catalog shows company's new line of recessed incandescent units utilizing HOLOPHANE CONTROLENS and reflectors, designed for easy access and relamping from the floor with a lamp changer in any type of installation. Marvin Mfg. Co., Los Angeles, Calif.

12 Punched catalog page gives construction, installation, and illumination data on new MP-45, two 40-watt fluorescent lamp fixture for commercial and other applications. Specifications, light distribution curves, and other data are included. Gibson Mfg. Co., Atlanta, Ga.

13 New engineering report completed at Case Institute covers use of perforated acoustical baffles as warm air diffusion outlets in a translucent suspended ceiling, specifically as supplied on company's GEOMETRIC systems. F. W. Wakefield Brass Co., Vermilion, Ohio.

14 Catalog page gives features of new C-824 corridor lighting unit employing HOLOPHANE 3-dimensional concept, showing specifications, installation data, illumination levels and suggested unit spacings. Holophane Co., Inc., New York, N. Y.

15 Anti static compounds for use in cleaning and destaticizing plastic parts used in lighting are described in folder covering numbers 79 and 79-OL made by this company. Qualities and suggested applications are included. Merix Chemical Co., Chicago, Ill.

16 Technical Bulletin 386-F gives construction and illumination characteristics of new general purpose floodlight, MDB-10, available with a variety of mountings. Crouse-Hinds Co., Syracuse, N. Y.

17 New "Light Rule" is pocket lighting calculator developed to solve general lighting problems quickly and accurately. Gives coefficients of utilization for a variety of fixtures, Room Index, etc., and sliding feature makes other calculations possible. Champion Lamp Works, Lynn, Mass.

18 Five new booklets show details of luminous ceiling installations in airline ticket offices, stores, offices, banks, and drafting rooms, suggesting wide variety, with and without acoustical baffles and telling advantages. Luminous Ceilings, Inc., Chicago, Ill.

19 Page describes "Space Arm," new adjustable boom for raising and hold in place pipes, conduit, fixtures, sheet metal duct, or anything up to 25 pounds in weight which must be secured overhead, as well as in lamp changing, etc. Lamp Snatchers Co., Chicago, Ill.

20 Five new catalog pages cover company's new "large area" 3800 Series and new recessed incandescent series with HOLOPHANE dropped CONTROLENS. Sunbeam Lighting Co., Los Angeles, Calif.

Offer good for two months

Circle numbers wanted. Enter name and address. Clip out and mail.

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New York 23, New York

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Company .....

Street .....

City ..... Zone ..... State .....

21 Eight-page booklet describes FLUR-O-LAMP disposal units for destruction of burned-out fluorescent lamps as well as many other materials. Also describes other equipment made by company. Laduby Co., Inc., Branford, Conn.

22 Eight-page brochure gives complete details on the "Gratelite Story"; construction and performance of this company's louver diffuser, both in fixtures and in louvered ceilings. Data sheet on new FALCON fluorescent fixture also available. Edwin F. Guth Co., St. Louis, Mo.

23 New 24-page catalog covers HY-LITE prestressed concrete standards for street and highway lighting, gives complete engineering tables and descriptive information on design features and mounting arrangements. American Concrete Corp., Chicago, Ill.

24 New and revised edition of remote-control wiring manual, publication number 16-284, for residential wiring design and installation is now available. Contains complete technical data on low-voltage system, provides suggested layouts and specifications. General Electric Co., Bridgeport, Conn.

25 Two new 3-color folders describe company's POLARIS and THINLINE luminaires in the "milestone" series of fluorescent fixtures. Folders give dimensional and lighting performance data, specifications, outstanding features. Mitchell Mfg. Co., Chicago, Ill.

26 New 8-page booklet describes company's line of luminous-tube transformers for indoor and outdoor application, publication number GEA-5859C. Includes ratings, data and dimensions for brick-bat hanger, indoor hanger, core-and-coil, and display sign transformers. General Electric Co., Schenectady, N. Y.

Employment Opportunities

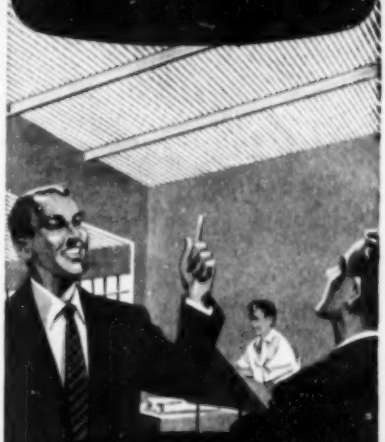
REPRESENTATIVES WANTED

Carter Lighting Co., manufacturers of high quality fluorescent circlines and other affiliated products, is opening following territories for representation: Upper New York State, Pennsylvania, South New Jersey, Washington, D. C., Maryland, Delaware, Kentucky, Georgia, Alabama, Virginia, North and South Carolina, Tennessee, Missouri, Iowa, Minnesota, Illinois, Indiana, Wisconsin and Texas. State background and experience in lighting distribution as well as other lines you are representing. Address: Dept. E, Carter Lighting Co., Chelsea, Massachusetts.

WANTED—SALES ENGINEER

To solicit standard and special contract work, Philadelphia area. Contacting owners, principals, architects, engineers, contractors; new buildings and relighting existing institutional public buildings, churches, banks, hotels, schools, etc. Top pay, salary or commission, to producer who can earn it. Eligibility for sick, accident and life insurance; pension and profit sharing after proving worth. Voigt Co., 1636 N. Carlisle St., Philadelphia 21, Pa.

Specify Acusti-luminus ceilings!



for LOW-COST CONTROL of LIGHT, SOUND and AIR FLOW

THE OVERALL CEILING OF LIGHT THAT INCREASES OVERALL EFFICIENCY!

Here is the trend in modern lighting! A solid ceiling of light that provides soft, shadowless illumination and also hides pipes, ductwork and sprinkler systems — it modernizes old and new buildings!

Made of unbreakable, corrugated LUMI-PLASTIC with noise absorbing ACUSTI-LOUVERS, it is glareproof, clean and easy to keep clean—labeled by Underwriters' Laboratories for installation *under* existing sprinkler systems!

Its low cost is quickly offset because people *see better, feel better, work better* under an ACUSTI-LUMINUS CEILING. Already over 3500 in use.

Luminous Ceilings, Inc.
Dept. 3, 2500 W. North Ave., Chicago 47, Ill.
Tell me where I can see it!
Send me your free booklet containing complete details about the ACUSTI-LUMINUS CEILINGS!
Name and title_____
Firm name_____
Address_____
City & State_____

Need Special Attention in Lighting Fixtures?

Here's "A la Carte" Service at "Blue Plate" Prices

Light & Power fluorescent fixtures are made in our own plant from start to finish . . . not merely assembled there. That's why we are among the few equipped to assist you in planning and research on specific jobs—and then go ahead and manufacture the complete fixtures to your particular requirements.

For the quality of "a la carte" fixtures at "blue plate" cost, write or wire today for our catalog and prices.

Distributed by Electrical Wholesalers Only

LIGHT & POWER UTILITIES CORP.
1035 Firestone Blvd. Memphis, Tennessee

five happy men

the architect
"I like the design possibilities."

the lighting engineer
"Variety in size, shielding and number of lamps gives me complete flexibility."

the contractor
"Easiest installation of any recessed fixture."

the maintenance man—"Easy hinging makes my job easier."

the owner—"Good-looking, good lighting . . . and surprisingly low in cost."

and **GARCY'S** new 5600 Series Recessed Lighting

2'x 2' | 2' x 4' | 4' x 4' | 2' x 8'

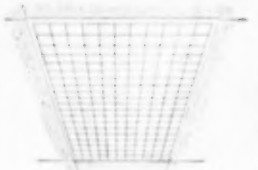
Variety in size and in number of lamps

2 ft. wide units for 2, 3 or 4 lamp rows. 4 ft. x 4 ft. units for 6, 8 or 10 lamp rows. Rapid start, slimline or fluorescent lamps.

NEW!

For any type of ceiling construction . . . plaster, aluminum grid and others

THREE TYPES OF SHIELDING
(Hinged plastic pictured above)



Hinged louver

Alba-lite glass in hinged frame

"The big five" on any lighting job, range from the man who pays the bills to the architect who picks the fixture.

Garcy's 5600 Series, by design, provide the kind of desirable features that make 'em happy, and keep them that way.

Design and lighting flexibility win a pleased nod from architects and engineers. Easy installation in any type of ceiling scores with contractors. Easy maintenance is a big feature for those concerned with upkeep. And the man who pays the bills is mighty happy with the handsome appearance and long-life construction details.

"Quality . . . *by design*" in Garcy's 5600 Series fixtures has the knack of pleasing everyone. Send for bulletin L-146.

GARCY Quality *by Design*

Garden City Plating & Mfg. Co., 1760 N. Ashland Ave., Chicago 22, Ill.

***In Canada:* Garcy Co. of Canada, Ltd., 191 Niagara St., Toronto**

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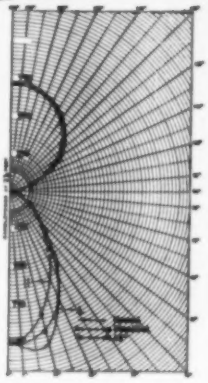
the ZANE "SENIOR"

FOR SCHOOLS and OFFICES

Designed to meet the highest standards for modern school and office lighting, the extremely versatile Zane "SENI 248 ST" luminaire has proved highly efficient in hundreds of installations.

In 45° x 45° shielding with steel sides, 75.5% efficiency is obtained. The unit is made for 35° x 25°, 35° x 45° and 45° x 45° shielding, with three different types of side panels.

ETL curves available on request. Zane fixtures are sold only through distributors.



LIGHT FLUX VALUES

Zone	Lumens Luminaire	Percent	Zone	Lumens Luminaire	Percent
0°-30°	723	14.5	0°-90°	1671	33.5
0°-40°	1040	21.0	90°-180°	2091	42.0
0°-60°	1443	29.0	0°-180°	3762	75.5

LUMINAIRE BRIGHTNESS

Shielding Angles 45°C-45°L

Angles	0°	0°	20°	30°	33°	40°	45°	20°L	30°L	40°L	45°L	90°	90°
C/Sq. In.	0.4	0.6	0.5	0.6	0.6	1.1	1.3	0.6	0.7	0.8	1.0	0.5	5.2

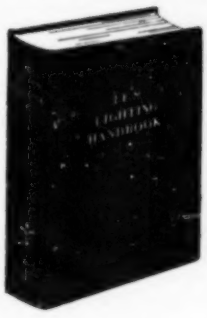
ETL Report Issued April 8, 1954

Write for "Senior" Folder 954

ZANE MANUFACTURING CO.

20 EAST CONCORD ST. BOSTON, MASS.

Is *YOURS* The Latest?...



You can't be sure you have *all the facts* about lighting unless you have a copy of the new . . .

Second Edition

I.E.S. LIGHTING HANDBOOK 1952

Prepared by I.E.S. technical committees, this 987-page lighting compendium contains 18 sections of lighting practice, theory and calculations . . . Appendices . . . Manufacturers' Reference Data . . . 655 photos, drawings, lighting tables, charts, graphs, to help you solve tough lighting problems.

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ILLUMINATING ENGINEERING SOCIETY

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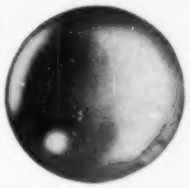
These Lancaster Stock Items Can Help Solve Your Lighting Glassware Problems

A

D

B



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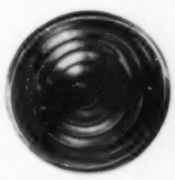

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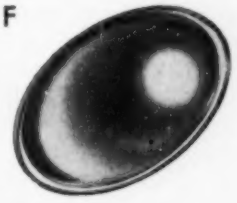


A. Pressed Flat Fresnel Lenses — heat-resisting and soda-lime glass — 3" to 8" diameters.

B. Ground and Polished Plano-Convex Condenser Lenses — soda-lime plate and heat-resisting glass — up to 10" diameters.

C. Semaphore Lenses — crystal and colored glass — various diameters.

D. Bullseye Lenses — crystal and colored glass — many diameters.

E. Shower Light Lens — crystal (inside frosted) — overall diameter, 5¼"; flange thickness approximately ¼"; face projection, 4¾"; overall height approximately 1¾".

F. Roundels — crystal and colored glass — up to 12" diameters.

LANCASTER GLASS

THE **Lancaster Lens** CO.

Lancaster, Ohio

☐ Please send me your price list for stock items of lighting glassware.

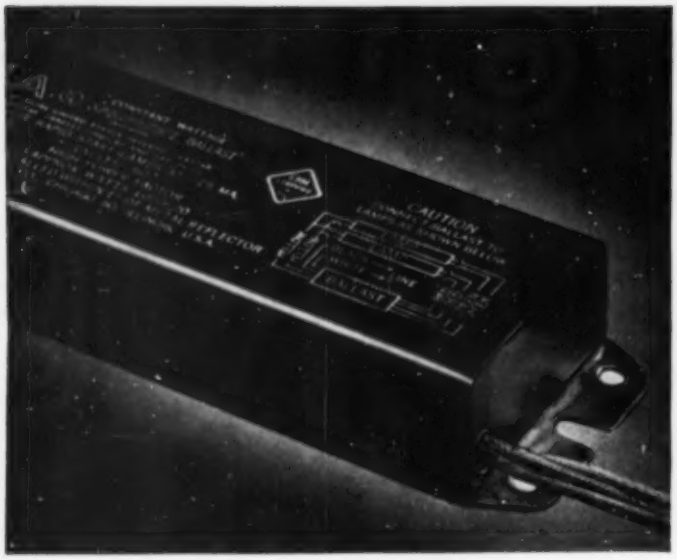
☐ Details of my custom lighting glassware problem are enclosed. I would appreciate your recommendations.

Name_____ Title_____

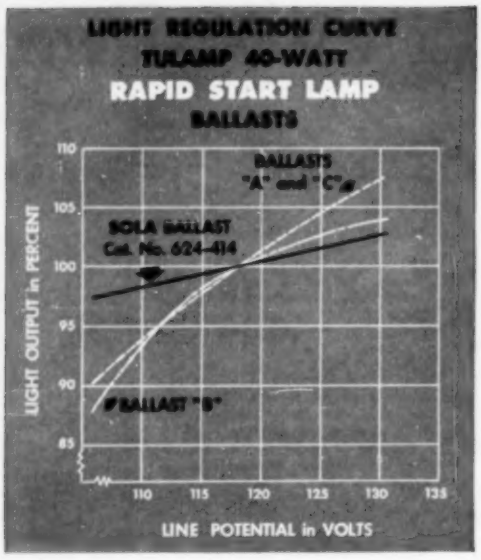
Firm_____

Street_____

City_____ Zone____ State_____



LOW, COMPACT CASE — Case height 1-13/16", length 8-5/16", width 3-1/8". Fits all standard, rapid-start channels. Weighs only 5-1/2 pounds. Leads are adequate length for easy hook-up without splicing, and clearly color-coded for quick identification. The case is permanently labeled and includes a wiring diagram and electrical ratings.



CONSTANT LIGHT OUTPUT — Light output characteristics of a typical Sola Constant Wattage Rapid-Start Ballast compared with three typical, non-regulated ballasts. Constant wattage is an exclusive premium feature in a ballast of this small size and light weight.

Guarantee constant light output on rapid-start lighting systems with Sola Constant Wattage Ballasts

You design or specify a rapid-start lighting system to deliver a specific number of foot candles at a specific working surface. Your customer buys your system on the basis of that expected performance . . . but what happens to light output and lamp life when line voltage varies?

With ordinary, unregulated ballasts, lumen output and efficiency will drop significantly when line voltage drops . . . lamp life is shortened by line voltage surges. Sola Constant Wattage Ballasts maintain lumen output within ±2.5% or less, with line voltage variations as great as ±10% . . . lamp life is protected by regulation of lamp current.

In addition, they offer many other advantages: reliable starting, cool operation, self-protection against damaging heat rise when lamps fail, absolute safety when relamping, unusually quiet operation, compactness, light weight and moderate price.

You automatically guarantee all the light your customer expects when your rapid-start installation is ballasted with Sola Constant Wattage units. You guarantee your customer's satisfaction through continuous, dependable performance. Write for full information, or request a Sola sales engineer to call for all the facts.

Reduces relamping . . . keeps lumen output constant

SOLA *Constant Wattage* **BALLASTS**

CBM CERTIFIED by ETL

WRITE FOR NEW RAPID-START BULLETIN 3K-FL-199

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • LIGHTING TRANSFORMERS for All Types of Fluorescent and Mercury Vapor Lamps. • SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3384 CLEVELAND 15: 1836 Euclid Ave., Prospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4383 • Representatives in Principal Cities

Leading Manufacturers of Fluorescent Tubes say:

CERTIFIED CBM CERTIFIED by ETL BALLASTS

are Tailored to the Tube

No one knows better the value of CERTIFIED CBM BALLASTS than the manufacturers of fluorescent tubes. For the satisfactory performance of their lamps is vitally dependent on the ballasts that operate them. Here's what they say:

CHAMPION *says:*

"Fluorescent lamps are designed to operate at specific electrical values. The use of auxiliary equipment that has been proven to meet these agreed upon standards will assure the user maximum value for his lighting dollar with a minimum of operational failures. Certified Ballasts are inexpensive insurance."

GENERAL ELECTRIC *says:*

"The life and light output ratings of fluorescent lamps are based on their use with ballasts providing proper operating characteristics. Ballasts that do not provide proper electrical values may substantially reduce either lamp life or light output, or both. Ballasts certified as built to the specifications adopted by the Certified Ballast Manufacturers (CBM) do provide values that meet or exceed minimum requirements. This certification assures the lamp user, without individual testing, that lamps will operate at values close to their ratings."

SYLVANIA *says:*

"The light and life ratings of fluorescent lamps are based on three hour burning cycles under specified conditions and with ballasts meeting American Standards Association specifications. Ballasts marked with the CBM emblem and certified by Electrical Testing Laboratories, Inc., meet ASA specifications."

WESTINGHOUSE *says:*

"Use ballasts that are tested and Certified by Electrical Testing Laboratories or ones that are otherwise known to meet the specifications of the lamp manufacturer. These will give best results with Westinghouse fluorescent lamps."

By using fluorescent fixtures that are equipped with CERTIFIED CBM BALLASTS you are assured long lamp life, full light output and trouble-free operation.

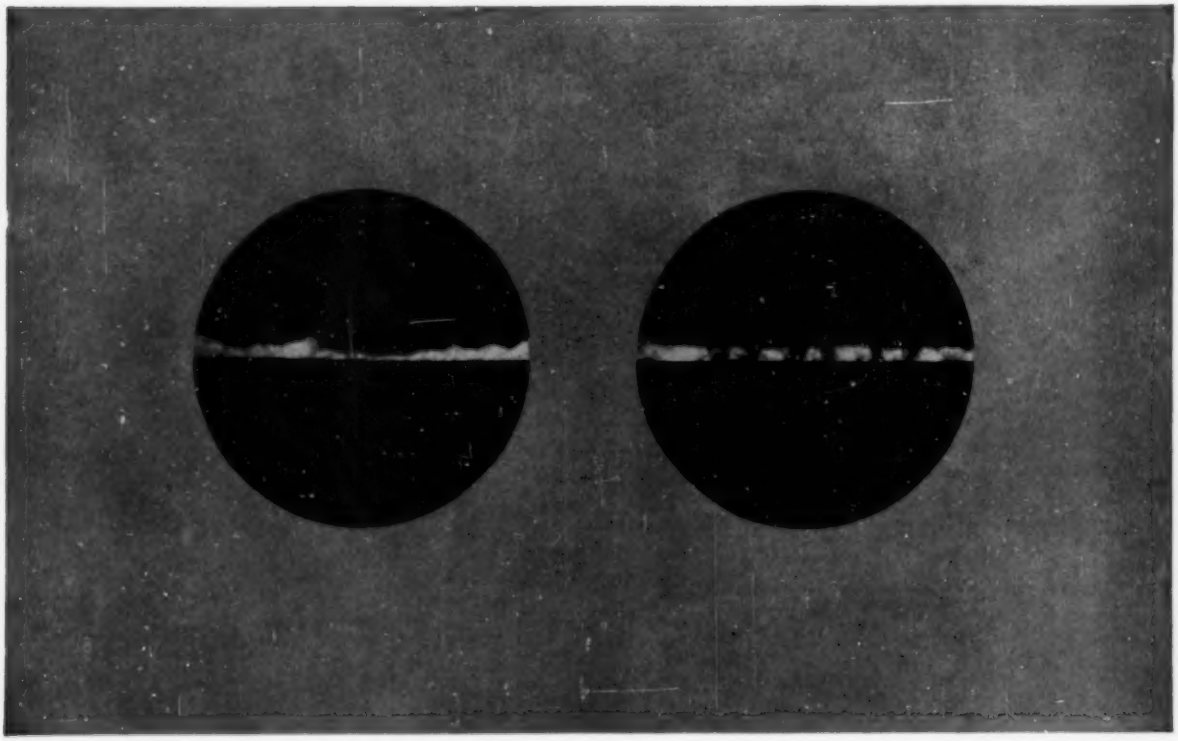
That's why CERTIFIED CBM BALLASTS merit the slogan—Tailored to the Tube.

CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

WESTINGHOUSE FLUORESCENT LAMPS
Start Bright—Stay Bright
Even After 7500 Hours...*do yours?*



You are looking through an 800 power microscope at cross sections of phosphor coating, cut from two fluorescent lamps. This coating controls the light output of your lamps. To obtain maximum output, both initially and throughout life, the coating must be uniform. Notice the smooth, even coating in the Westinghouse Lamp on the right; how there are no severe peaks and valleys to interfere with light output. This smoother coating is one reason standard Westinghouse Lamps give 80% of their high initial light output after 7500 hours of daily use. You can't check all the lamps you buy under a microscope, but with Westinghouse you can be sure of maximum light output throughout an average life of over 7500 hours.

For details, contact your Westinghouse Lamp Supplier, or write to Westinghouse Lamp Division, Bloomfield, New Jersey.

YOU CAN BE SURE...IF IT'S

Westinghouse

Tune in each week on TV... Westinghouse Studio One